Appendix 5.4-C

Essential Fish Habitat Assessment

EFH ASSESSMENT FOR THE CAPE WIND PROJECT

NANTUCKET SOUND

May 2004

Prepared for the U.S. Army Corps of Engineers

Prepared by:

Battelle
397 Washington St.
Duxbury MA 02332

and

ESS Group, Inc.
888 Worcester Street, Suite 240
Wellesley, Massachusetts 02482

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Many marine habitats are critical to the productivity and sustainability of marine fisheries. The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) require that an Essential Fish Habitat (EFH) consultation be conducted for any activity that may adversely affect important habitats of federally managed marine and anadromous fish species. EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” (16 U.S.C. 1802(10)). “Waters” in the above definition refer to the physical, chemical and biological properties of aquatic areas that are currently being used or have historically been used by fish. “Substrate” refers to sediment, hard bottom, or other underwater structures and their biological communities. The term “necessary” indicates that the habitat is required to sustain the fishery and support the fish species’ contribution to a healthy ecosystem. The term “adverse effect” means any impacts which reduces quality and/or quantity of EFH. Adverse affects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species, and their habitat, and other ecosystem components. Adverse effects may be site- specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.910).

2.0 Proposed Action and Alternatives

2.1 Description of Proposed Action

The offshore wind energy project proposed by Cape Wind consists of the installation and operation of 130 Wind Turbine Generators (WTGs) on Horseshoe Shoal (Alternative #1) in Nantucket Sound. Two additional sites within Nantucket Sound have been evaluated as alternatives for construction of the WTG array. All three sites, depicted in Figure 1, are located outside of the Massachusetts’ three-mile state jurisdictional limit, exclusively within federal waters of Nantucket Sound.

The WTGs will produce an average of 170 megawatts (MW) (up to a maximum output of 454 MW) of clean renewable energy using the natural wind resources off the coast of Massachusetts. Wind-generated energy produced by the WTGs will be transmitted via a 33 kV submarine transmission cable system (inner-array cables) to the Electric Service Platform (ESP) centrally located within the WTG array. The ESP will then take the wind-generated energy from each of the WTGs and transform and transmit this electric power to the mainland electric transmission system via two 115 kV alternating current (AC) submarine cable circuits (submarine cable system) to the selected landfall site at New Hampshire Avenue in Yarmouth, Massachusetts. The submarine cable system will then interconnect via horizontal directional drilling (HDD) with the upland cable system. The upland cable system will be installed underground within existing rights of way (ROWs) and roadways in the Town of Yarmouth and Barnstable, where it will interconnect with an existing NSTAR Electric Barnstable Switching Station. The clean renewable energy produced by the Wind Park will be transmitted by this cable system to the electric transmission system serving Cape Cod, the Islands of Nantucket and Martha's Vineyard ("the Islands"), and the New England region.

Installation of the WTGs will comprise four activities: 1) installation of the foundation monopiles; 2) erection of the wind turbine generator; 3) installation of the inner-array cables and 4) installation of the scour protection mats. The monopiles will be installed into the seabed by means of pile driving ram or vibratory hammer and to an approximate depth of 85 feet (26 meters) into the seabed. This will be repeated at all WTG locations. As the monopiles and WTGs are completed, the submarine inner-array cables will be laid via jet plow embedment in order to connect the string of wind turbines (up to 10 WTGs), and then the seabed scour control system will be installed on the seabed around each monopile. This will consist of a set of six scour-control mats arranged to surround the monopile. Each mat is 16.5 feet by 8.2 feet (5 meters by 2.5 meters) with eight anchors. It is anticipated that the process of completing one string of WTGs (10 WTGs with associated inner-array cable and scour mats) will take up to approximately one month.

The ESP design is based on a piled jacket/template design with a superstructure mounting on top. The platform jacket and superstructure will be fully fabricated on shore and delivered to the work site by barges. The jacket will be removed from the barge by lifting with a crane mounted on a separate derrick barge. The jacket assembly will then be sunk and leveled in preparation for piling. The six piles will then be driven through the pile sleeves to the design tip elevation of approximately 150 feet (46 meters). The piles will be vibrated and hammered as required. After the ESP is fully constructed, installation of the inner-array cables and the high voltage transmission cables will be installed. These cables will be routed through J-tubes located on the outside of the support jackets. Once the inner-array cables are connected to the ESP, the scour mats will be installed to the ESP piles utilizing a similar design as the WTG foundations.

The two 115 kV submarine cables linking the ESP to the landfall location will be embedded by jet plow approximately six feet below the sea floor, with approximately 20 feet (6.1 meters) of horizontal separation between circuits.

For more details on the construction and installation of the proposed Project, please refer to Section 4.0 of the DEIS-DEIR.

2.2 Alternatives to the Proposed Action

The Applicant has conducted a thorough analysis of alternative technologies and site locations for the Project (see Section 3.0 of the DEIS), considering both terrestrial and offshore locations throughout New England. The alternative analysis determined that Nantucket Sound is an acceptable environment for installation of an offshore Wind Park based on the application of preliminary screening criteria (see Section 3.4.1 of the DEIS / DEIR). Additional siting analysis was then conducted to evaluate specific locations within the Sound. Nantucket Sound alternative WTG array sites (Figure 1) include Horseshoe Shoal (Site 1 – the Proposed Alternative Site), eastern Nantucket Sound near the Monomoy Island area (Site 2 – Monomoy-Handkerchief Shoal), and southern Nantucket Sound near the Hawes and Tuckernuck Shoals area (Site 3 – Tuckernuck Shoal).

2.3 Affected Environment

This section describes the physical and biological characteristics in Nantucket Sound in general and in the Proposed Alternative Site and other alternative sites in Nantucket Sound when possible. Much of the information presented in this section is found in the DEIS/DEIR/DRI prepared by the USACE pursuant to the National Environmental Policy Act (NEPA). Readers are encouraged to review referenced literature (Section 6 of this Appendix) and the DEIS/DEIR/DRI for more detailed information on the affected environment of Nantucket Sound and potential environmental consequences of the proposed action.

2.3.1 Physical Environment

This section describes the physical environment of Nantucket Sound, and includes subsections on hydrography, currents, salinity, temperature, sediment distribution, sediment quality, and sediment transport. Information is drawn from published literature and from studies conducted by the Applicant. The following description of the physical environment of Nantucket Sound provides a basis for understanding the oceanographic processes that affect potential EFH and federally managed species in this area.

Hydrography: In general, the bathymetry in Nantucket Sound is irregular, with a large number of shoals present in various locations throughout the glacially formed basin. Charted water depths in the Sound range between one and 70 feet at mean lower low water (MLLW).

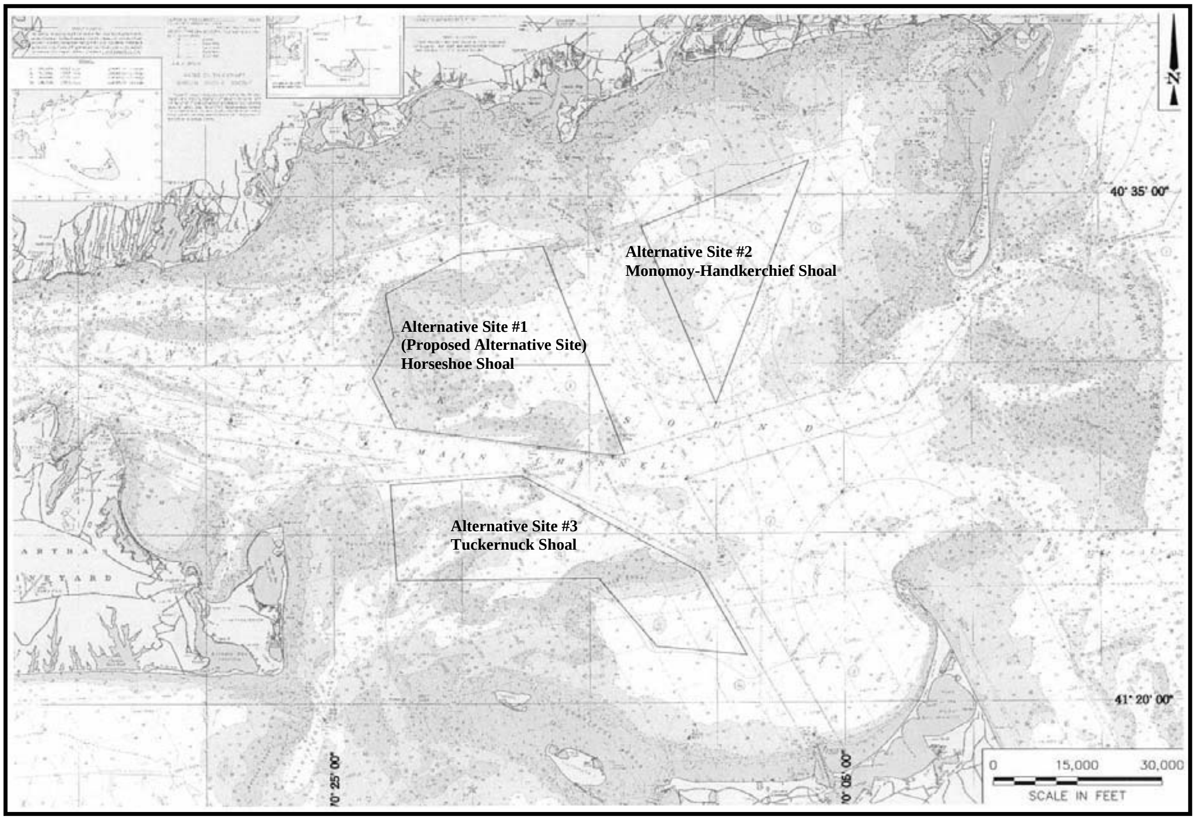


Figure 1. Location of the Proposed and alternative wind park sites in Nantucket Sound

Each of the alternatives sites is located in a shoal area within Nantucket Sound. The shoals have complex shapes, as shown in Figure 1. Water depths on each shoal range from less than 10 feet deep to more than 50 feet deep at low tide. The Proposed Alternative Site (Site 1) is located on Horseshoe Shoal, a prominent geological feature in the center of the Sound. Depths on Horseshoe Shoal are as shallow as 0.5 feet at MLLW. Site 2 is located on Monomoy-Handkerchief Shoal, in the eastern part of Nantucket Sound west of Monomoy Island. Monomoy-Handkerchief Shoal has an extensive area of shallows averaging 6 to 8 feet deep. Site 3 is located on Tuckernuck Shoal, in the southern portion of Nantucket Sound, northwest of Nantucket and Muskeget Islands and east of the opening between Nantucket and Martha's Vineyard. Localized areas on the crest of Tuckernuck Shoal are as shallow as 2 feet.

Water depths between Horseshoe Shoal and the Cape Cod shoreline are variable, with an average depth of approximately 15 to 20 feet at MLLW. Along the submarine cable system route, depths vary from about 16 to 40 feet at MLLW, with an average depth of approximately 30 feet at MLLW. Water depths in Lewis Bay and Hyannis Harbor are variable ranging from eight to 14 feet at MLLW in the center of the Bay to less than five feet at MLLW along the perimeter and between Dunbar Point and Great Island. There are three navigation channels in Lewis Bay: the Federal Navigation Channel providing access to Hyannis Inner Harbor (authorized depth –13 feet MLW); and two privately maintained channels, one into Mill Creek (reported depth of –two feet MLLW in 1983) and the other northeast of Great and Pine Islands (approximately seven feet deep at MLLW).

The submarine cable system route will extend outside the eastern edge of the federal channel into Lewis Bay and will then turn east, north of Egg Island, to make landfall between Mill Creek and the privately maintained channel northeast of Great and Pine Islands. Water depths along this route in Lewis Bay range from five to 15 feet, with an average of ten feet. The shallowest portions of Lewis Bay/Hyannis Harbor along this route exist between Great Island and Dunbar Point, with depths of one to four feet at MLLW.

Tidal Flow and Circulation: The water currents in Nantucket Sound are driven by strong, reversing, semidiurnal tidal flows. Wind-driven currents are only moderate because of the sheltering effect of Nantucket and Martha's Vineyard. The tidal range and diurnal timing are variable because of the semi-enclosed nature of the Sound and the regional variations in bathymetry. Typical tidal heights are in the range of one to four feet with tidal surges of up to approximately ten feet having been recorded during hurricanes (Bumpus et al. 1973; Gordon and Spaulding 1979). Times of high and low tides vary in different parts of the Sound by up to two hours.

Tidal flow and circulation within the Sound generate complex currents, the direction of which form an ellipse during the two tidal cycles each day. The complex bathymetry of Nantucket Sound forces the tidal ellipses to take different shapes in different regions of the Sound. Just off the coast of the south shore of Cape Cod, there is a strong rectilinear, semi-diurnal tidal flow approximately parallel to the coast (Goud and Aubrey 1985). The tidal current flows to the east during the flood tide (incoming) and to the west during the ebb tide (outgoing). Peak tidal currents often exceed two knots (Bumpus *et al.*1973). The intensity of tidal flow, in general, decreases from west to east. There is a slow net drift of the water mass toward the east in the Sound. The net drift is about 200m^2 per tidal cycle, roughly 5% of the total easterly and westerly tidal flows (Bumpus *et al.* 1971).

To characterize site-specific tidal and wind-driven currents at the Proposed and alternative sites in Nantucket Sound, analytical models were applied (Appendix 5.2-A), with the results as follows. Flood currents on the shoals are generally directed easterly and ebb currents are generally directed westerly. Local changes in tidal current direction occur on the shoals due to the nearby shoreline shape and bathymetric features. For example, the direction of tidal currents at Handkerchief Shoal is directed around Monomoy Island and have more of a southeast (flood)/northwest (ebb)tendency. Currents at Horseshoe Shoal are diverted slightly around the shallowest portion of the shoal. Flood currents also are generally stronger than ebb currents and spring tidal currents are approximately 15-20 percent stronger than mean tidal currents. Tidal current velocities were calculated to be approximately 2 feet/second at Horseshoe Shoal; less than 2 feet/second at Tuckernuck Shoal, and more than 2.5 feet/second at Monomoy-Handkerchief Shoal. Wind-driven current velocities modeled at Horseshoe Shoal were found to be much lower than tidal velocities and concentrated over the crest of the shoal (Appendix 5.2-A).

Salinity: Salinities in Nantucket Sound are near oceanic, and salinity gradients are small due to strong lateral and vertical mixing. River runoff into Nantucket Sound is low, so there is little dilution of ocean waters with fresh water. Surface and bottom water salinities vary seasonally and spatially from about 30 to 32.5 ppt (Bumpus et al. 1973). Surface water salinities throughout the Sound are just over 31 ppt during the summer, and are uniformly about 32 ppt in the winter (Limeburner et al. 1980).

Temperature: The annual cycle of surface and bottom water temperatures in Nantucket Sound encompasses a range of about 45° F, from nearly 30^{o}F (-1° C) in the winter to as high as 75^{o}F (24° C) in the late summer (Bumpus et al. 1973). Temperature extremes are greatest in coastal ponds and estuaries and the seasonal temperature cycle is smallest in the deeper parts of the Sound. However, because the Sound is shallow and well mixed, there is little lateral temperature variation and vertical temperature stratification. There is a tendency in the summer for surface water temperature to increase from east to west in Nantucket Sound. In the winter, the gradient is in the opposite direction (Limeburner et al. 1980). This change is caused by the intrusion of warmer continental shelf water into the Sound from the east during the summer months.

Bottom water temperature varies less and changes more slowly on a seasonal basis than surface water temperature. The highest bottom water temperature in Nantucket Sound during summer is in the range of 61 to 66^{o}F (16 to 19° C) (Theroux and Wigley 1998). Warmest bottom water temperatures are near the coast of the south shore of Cape Cod, and temperature decreases with distance offshore. Coolest bottom water temperatures in Nantucket Sound are in the range of 32 to 35.6^{o}F (0 to 2° C), and become warmer with distance from the Cape Cod and Nantucket shorelines.

Sediment Distribution: Nantucket Sound generally contains sand- and silt-sized surficial marine sediments, with localized patches of clay, gravel and/or cobbles. The sediments were derived from material originally transported from upland areas during glacial and post-glacial processes, and are now continually sorted and reworked by tidal, current, wave and storm actions. Shallow marine sediments were collected in vibracores and benthic grabs during 2001 and 2002 across the Proposed and alternative sites. Visual analysis of sediments within the 0- to 2-foot depth range beneath the seabed indicates the presence of fine- to coarse-grained sands in areas of relatively shallow bathymetry, with fine to silty sands and silts predominating in deeper surrounding waters across the three sites (for additional vibracore information please see Section 5.1 of the DEIS/DEIR). This distribution is consistent with the higher-energy marine environments typically found in shallower waters, where finer sediments are winnowed away by current and wave action. The fines then settle out and deposit in the surrounding lower-energy deeper water areas.

Medium-grained sands predominate atop the U-shaped Horseshoe Shoal, with fine-grained sands found in the east-opening embayment. Localized fractions of silt, gravel and/or cobbles, consistent with glacial drift may also be present in the area. Fine to silty sands were encountered in the deeper water portions surrounding the shoal area. Fine sands predominate in the western and central portions of Monomoy-Handkerchief Shoal, with silty sands to the east in deeper waters. Across Tuckernuck Shoal, fine sands predominate, with an area of medium to coarse sands traversing the center of the shoal and oriented parallel to the tidal currents sweeping between Martha's Vineyard and Nantucket. Silty sands were encountered to the east of Tuckernuck Shoal, again in the deeper water areas surrounding the shoal.

A geophysical survey across Horseshoe Shoal conducted in 2001 identified areas of sand waves, especially in the south central portion of the shoal. The sand wave crests were oriented generally in a north-south direction, with long period wavelengths ranging between 100 to 600 feet. Short period sand waves are located between the larger crests. The average sand wave height was 4 to 5 feet, but waves as high as 15 feet were found. The size of the sand waves attest to the dynamic shallow water environment on Horseshoe Shoal. The symmetry of the sand waves indicates migration to the east or west, depending on where they formed on the shoal. In other areas of the shoal, the majority of the seafloor contained few significant features and smooth sandy bottoms (Ocean Surveys, Inc., July 2002).

Sand waves were also identified within the Tuckernuck Shoal area (as well as across Horseshoe Shoal) during a geophysical survey conducted by USGS in 1976 and 1977. Sand waves were not identified by USGS at that time across what is now the Monomoy-Handkerchief Shoal alternative site (O'Hara and Oldale, 1987). The geophysical survey conducted in 2001 did not include those two alternative site areas.

Along the submarine cable system route, seabed sediments contain fine to coarse size sands, with patches of clay, silt, gravel and/or cobbles. Intermittent glacially transported boulders may also be present along the route.

Sediment Quality: Bulk chemical analyses were performed on selected core samples obtained from the WTG array area and along the proposed submarine cable route into Lewis Bay to determine whether the sediments could pose an environmental concern. To assess the relative environmental quality of these sediments, the analytical laboratory results for the targeted chemical constituents were compared to sediment guidelines typically used by agencies to evaluate risk from contaminants in marine and estuarine sediments (Effects Range-Low (ER-L) and Effects Range-Median (ER-M) guidelines). None of the targeted chemical constituents were detected in the samples above ER-L or ER-M guidelines (Long et al., 1995) for marine sediments. The ER-L and ER-M guidelines use numerous modeling, laboratory, and field studies to establish values for evaluating marine and estuarine sediments. Concentrations below the ER-L represent a concentration range in which adverse effects are rarely observed. Section 5.1 of the DEIS has more detailed information on sediment quality in the Project Area.

Sediment Transport: Analytical sediment transport modeling was performed to determine the extent to which existing wave and current conditions are likely to lift and move sand at the Proposed and alternative project sites (see Appendix 5.2-A of the DEIS).

Generally the analysis found that active sediment transport occurs at all of the shoals, even under typical wave and tidal current conditions. The highest sediment transport rates are focused locally on the shallowest portions of the shoals, and there is relatively little sediment transport in the deeper regions for typical conditions. The most dynamic transport conditions are shown to be on Monomoy-Handkerchief Shoal. This is expected due to the extensive shallow flats in this area, relatively swift tidal currents that funnel at this location between the Sound and Ocean, open western exposure to waves generated within the Sound, and relatively fine sediment grain size at this location. Although Tuckernuck Shoal experiences the lowest tidal currents, the potential sediment transport rate for typical conditions is on the order of Horseshoe Shoal due to the fine grain size of sediments at Tuckernuck Shoal.

Bed load transport on Horseshoe Shoal is typically an order of magnitude greater than suspended load transport. This is expected at the Horseshoe Shoal site, where sediments are relatively coarse. It is also expected since the level of wave and current energy under typical conditions is not sufficient to lift and suspend large volumes of sediment within the water column.

At all sites, spring tidal currents initiate approximately 20 percent more transport than mean tidal currents, and wind-driven currents from a sustained l5 knot westerly wind have a similar effect by comparison. The greatest impact on sediment transport initiation is due to waves. Larger locally generated waves within Nantucket Sound can cause a significant increase in sediment transport. If swell waves from the ocean impact the Proposed or alternative project sites, sediment transport rates can increase as much as one hundred fold, even for typical swells propagating from the Atlantic Ocean (e.g., four to five foot height with an eight second period). Since flood currents are stronger than ebb currents, there is a long-term forcing mechanism to cause the net transport of sediment to the east, particularly at Horseshoe Shoal.

2.3.2 Biological Environment

This section describes the biological environment of Nantucket Sound, and includes subsections on submerged aquatic vegetation, the plankton community, and benthic communities. Information was drawn from published literature and from studies conducted by the Applicant. The following description of the biological environment of Nantucket Sound provides a basis for understanding the biological and ecological conditions that make these areas desirable as habitat for fish species.

Submerged Aquatic Vegetation: Seagrass beds and other submerged aquatic vegetation (SAV) provide habitat for many species of benthic invertebrates and fish. The MADEP Wetlands Conservancy Program has mapped SAV beds one quarter acre or larger in size along the coast using aerial photography, GPS, and a digital base map. Mapping was completed in 1995 and 2000; the 1995 data is available from MassGIS. One SAV bed has been mapped within Lewis Bay, located to the west of Egg Island in the Town of Barnstable. A December 2002 telephone conversation with Mr. Charles Costello of the MADEP Wetlands Conservancy Program indicates that the mapped SAV bed has not changed much in size between 1995 and 2000. In addition to the mapped SAV in Lewis Bay, MADEP has mapped areas of SAV in Hyannis Harbor in the Town of Barnstable and to the west of Great Island in the Town of Yarmouth. Field investigations have been conducted to determine the extent of mapped SAV beds in the vicinity of the proposed Project. The submarine cable system will be no closer than 70 feet from the edge of the eelgrass bed located near Egg Island.

Plankton Communities: Plankton refers to those plants (phytoplankton) and animals (zooplankton) that cannot maintain their distribution against the movement of water masses. Individual plankters are generally very small or microscopic; however, organisms such as jellyfish are often considered with the plankton community. Review of the scientific literature suggests that little information exists describing the plankton communities of Nantucket Sound. Their abundance and distribution is of particular interest since, in the case of phytoplankton, they form the base of the marine food web. Phytoplankton dynamics in all waterbodies, including those of Nantucket Sound are controlled by a suite of variables including light, temperature, nutrients, grazing by higher trophic level organisms and species interactions. Physical characteristics of the water column such as turbulence, stratification, and current patterns are also likely to influence patterns of species distribution.

Sherman et al. (1988) describes the phytoplankton community for the southern New England shelf area. Although, not specific to Nantucket Sound, the findings for this larger area are likely to be generally applicable to the Sound. Sherman et al. (1988) noted that in southern New England waters during February and March, small diatoms including *Leptocylindricus danicus*, *Skeletonema costatum* and *Thalassiosira nordenskioldii* predominate out to the 50-m (164 foot) isobath. In April an increase in *Phaeocystis pouchetti* is sometimes observed. Other widespread species include *Nitzchia seriata*, *Rhizosolenia hebetate* and *R. shrubsoleia*. Small naked dinoflagellates including several *Gymnodinium* species are abundant. The diatom *Skeletonema costatum* appears to dominate the shelf area from August through October. Falkoski et al. (1988) suggested that phytoplankton assemblages in the region may receive seed populations from Georges Bank and Nantucket Shoals which may be modified by biological and physical processes rather than simply advected along the shelf. As waters move southwest along the shelf, phytoplankton species may be cropped, grow differentially, or sink forming distinct assemblages.

Benthic Communities: Based on literature reviewed, the most abundant benthic fauna taxa in Nantucket Sound are crustaceans and mollusks, followed by polychaete worms (annelids) (Sanders, 1956; Wigley, 1968; Pratt, 1973; Theroux and Wigley, 1998). Among the crustaceans, amphipods are reported to be by far the most abundant. Bivalves are reported to be the most abundant and diverse of the mollusks in Nantucket Sound (Pratt, 1973). MDMF (2001a) reports that a heavily populated area of northern quahog (*Mercenaria mercenaria*) exists in the shoals east of Horseshoe Shoal. The annelid fauna is also reported to be diverse (Theroux and Wigley, 1998). Maurer and Leathem (1981) identified 333 species of polychaete worms in sandy sediments from Georges Bank and Nantucket Shoals. Many of these species occur in the deeper waters of Nantucket Sound. Biomass is reported to be lower in shallow areas of Nantucket Sound, including the Proposed Alternative Site (Theroux and Wigley, 1998). This is most likely due to the unstable sandy sediments in these shallow waters. These polychaetes are a favorite prey of several species of demersal fish, particularly winter flounder (*Pseudopleuronectes americanus*) (Buckley, 1989).

Based on the benthic survey conducted in the late summer of 2001, ninety-five taxa were identified in the benthic grab samples collected for the Project from the Horseshoe Shoal area (Appendix 5.3-A). Consistent with previous research, the most diverse and abundant taxonomic class found was *Amphipoda* (1,128 individuals/m^2) (amphipods, or scuds) (Appendix 5.3-A, Table 3). Benthic surveys conducted during late spring of 2002 (Appendix 5.3-B) also found that amphipods were a dominant group, however, abundances observed during late spring 2002 were significantly lower ($p<0.10$) than those observed during late summer of 2001. The late spring 2002 survey was conducted to assess Horseshoe Shoal as well as two alternative areas, Tuckernuck Shoal and Monomoy Shoal. The most dominant taxon found during 2002 was Nematoda (3,804 individuals/m^2), followed by Ampeliscidae (1,644 individuals/m^2) (four-eyed amphipod) (Appendix 5.3-B, Table 3). With regard to differences among the three alternative sites, benthic diversity was found to be significantly higher ($p<0.10$) on Monomoy Shoal than on Tuckernuck Shoal while no significant difference ($p>0.10$) was found between the benthic diversity of Horseshoe Shoal and either of the two other alternative areas assessed. Benthic organism abundance did not differ significantly ($p>0.10$) among the three alternative sites (Appendix 5.3-B, Table 5).

Differences in benthic organism abundance and community composition were expected to be related to differences in bottom substrate type, water depth or possibly due to the presence or absence of sand wave formations (unstable, shifting sediment). These physical habitat features were assessed during the 2002 study. In general, results indicated that benthic diversity was significantly higher ($p<0.10$) in shallow waters characterized by fine-grained sediments and absent of sand waves. Organism abundance was found to be much less dependent on depth and sediment type. Abundances were generally found to be significantly lower ($p<0.10$) in areas with sand waves. Overall, the benthic community composition and relative abundance documented as part of the 2001 and 2002 studies (Appendices 5.3A and 5.3B) was consistent with data reported in earlier studies on Nantucket Sound, Georges Bank, and the Southern New England Shelf (Sanders, 1956; Wigley, 1968; Pratt, 1973; Theroux and Wigley, 1998). The sandy substrate of Nantucket Sound is dynamic and mobile, as is indicated by ripple marks and sand waves. The magnitude and frequency of sand movements has a marked influence on the composition and abundance of the benthic communities. Organisms living on or in these sandy sediments are expected to be adapted for movement or settlement in sand and recovery from burial. Section 5.3 of the DEIS has more detailed information on benthic communities in Nantucket Sound.

3.0 FEDERALLY MANAGED SPECIES

3.1 Species with EFH Designation

In the Northeast, National Marine Fisheries Service (NMFS) works with the New England Fishery Management Council and the Mid-Atlantic Fishery Management Council to define essential habitat for key species in New England coastal waters, including those of Nantucket Sound. The Management Councils and NMFS designates EFH for numerous species in association with a mapped grid of 10 x 10 minute squares, which covers all marine habitat along the United States coast. The Project Area lies within four of these 10 x 10 minute squares in

Nantucket Sound (Figure 2). This location requires the investigation of 17 federally managed fish and three federally managed invertebrate species for this assessment (Table 1). In addition, two federally managed species have designated EFH in one or more of the alternative sites in Nantucket Sound, but not at the Proposed Alternative site, Pollock and Atlantic sea herring. Project specific habitat conditions may indicate that EFH does not exist for some of these species or life stages in the Project Area.

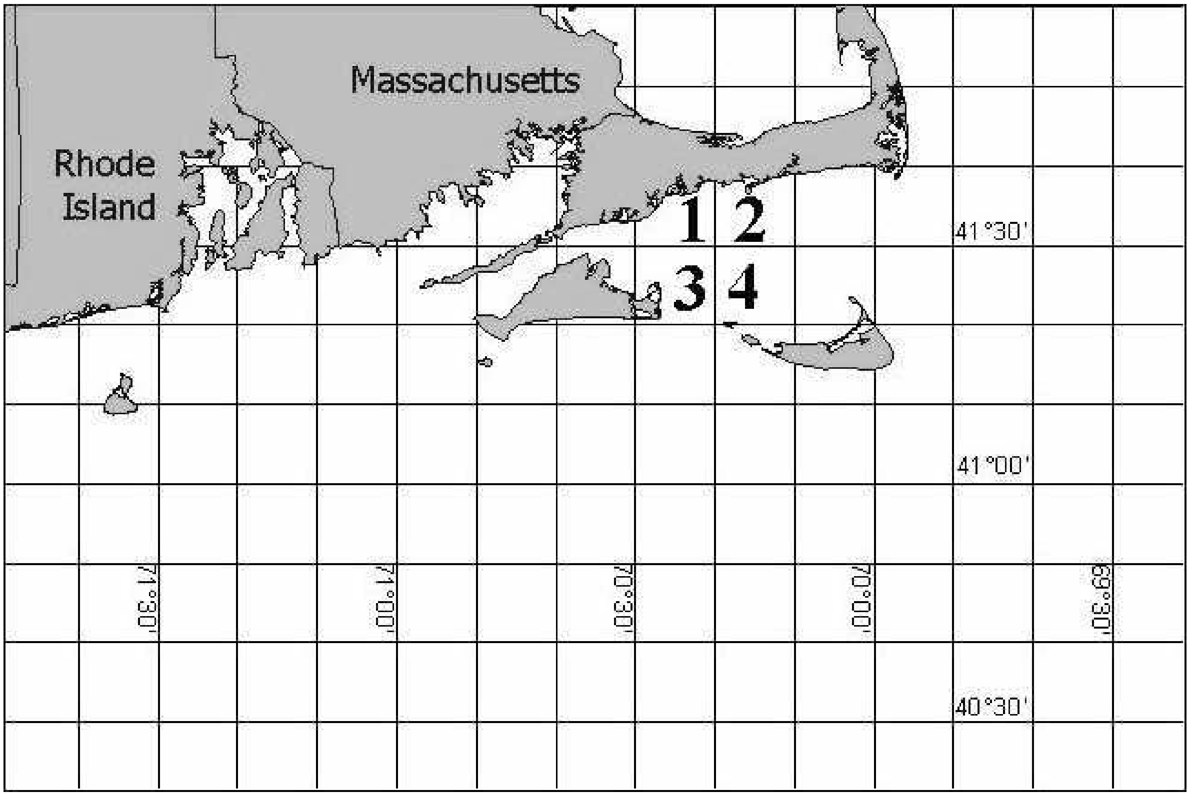


Figure 2. NMFS 10 x 10 minute squares for EFH designation

Table 1. Summary of specific life stage EFH designations for species in the NMFS designated 10 x 10 minute squares encompassing the Proposed Alternative Site (Site 1) and Alternative Sites 2 and 3 in Nantucket Sound.

SPECIES Common Name	Scientific Name	EGGS	LARVAE	JUVENILES	ADULTS	SPAWNING ADULTS
Atlantic cod	Gadus morhua				X	
Pollock*	Pollachius viren			X		
Scup	Stenotomus chrysops			X	X	
Black sea bass	Centropristis striata		X	X	X	
Winter flounder	Pseudopleuronectes americanus	X	X	X	X	X
Summer flounder	Paralichthys dentatus	X	X	X	X	
Windowpane	Scophthalmus aquosus				X	X
Yellowtail flounder	Limanda ferruginea			X		
Atlantic sea herring**	Clupea harengus			X		
Atlantic butterfish	Peprilus triacanthus	X	X	X	X	
Atlantic mackerel	Scomber scombrus	X	X	X	X	
King mackerel	Scomberomorus cavalla	X	X	X	X	
Spanish mackerel	Scomberomorus maculatus	X	X	X	X	
Cobia	Rachycentron canadum	X	X	X	X	
Blue shark	Prionace glauca				X	
Shortfin mako shark***	Isurus oxyrhinchus			X		
Bluefin tuna	Thunnus thynnus			X	X	
Little skate	Leucoraja erinacea			X	X	
Winter skate	Leucoraja ocellata			X	X	
Long-finned squid	Loligo pealei			X	X	
Short-finned squid	Illex illecebrosus			X	X	
Surf clam	Spisula solidissima			X	X	

Note: Designations apply to Sites 1, 2, and 3 unless noted with an asterisk.
* Designated EFH at Site 2 only
** Designated EFH at Sites 2 and 3 only
*** Designated EFH at Sites 1 and 3 only

3.2 Likelihood of Occurrence

Although the species in Table 1 are reported by NMFS to have designated EFH in the four 10 x 10 minute grid squares that encompass the Project Area, a review of the physical and chemical properties of Nantucket Sound along with the NMFS definition of species-specific habitat conditions has determined that EFH may be present for some of these species and their life history stages and may not be present for several of the others. NMFS uses the Estuarine Living Marine Resources (ELMR) Program database provided by NOAA for the designation of inshore EFH. NOAA has provided a portion of this database specifically for Nantucket Sound, which was also used to determine if EFH was present in the Project Area for some species. The information contained within this database along with a review of the physical and chemical properties of the Project Area suggests that EFH for Atlantic cod, scup, black sea bass, winter flounder, summer flounder, windowpane flounder, Atlantic butterfish, Atlantic mackerel, little skate, winter skate, long-finned squid, short-finned squid, and the Atlantic surf calm should be present within the Project Area. The information also suggests that EFH for yellowtail flounder, bluefin tuna, king mackerel, Spanish mackerel, cobia, the blue shark and shortfin mako shark should be absent from the Project Area.

A likelihood of occurrence analysis conducted for this Project supports these findings (see Appendix 5.4-A of the DEIS). Twenty-five years of spring and fall research trawl data from Massachusetts Division of Marine Fisheries (MDMF) was analyzed for species presence/absence and numbers per trawl to determine whether species collected from the Proposed and alternative sites in Nantucket Sound as well as the overall Project Area are considered very common, variably common, less common, rare, vary rare or not observed at all. Additionally, the data were evaluated to determine whether individual species were potentially increasing or decreasing on any given site or regionally. It is important to note, however, that although these MDMF data were used for this analysis, the design of the MDMF monitoring program cannot statistically test for similarities/differences in finfish abundance and/or distribution between specific sites. The timing of the surveys (May and September) does not allow the surveys to represent the abundance and distribution of finfish over the entire year, but is timed to coincide with seasons when either adults or juveniles are available inshore. Additionally, the gear type (otter trawls) and methods used during the survey are similar to gear used by commercial fishermen and are more effective at collecting demersal and semi-pelagic species. True pelagics (i.e., Atlantic mackerel) and highly migratory species such as bluefin tuna are not frequently caught in bottom trawls and may therefore be under-represented in the MDMF research trawl data.

Seventy-eight species were observed from 1978 through 2002 in the MDMF research trawls. Species with EFH designation that were not observed at least once during these years included yellowtail flounder, bluefin tuna, king mackerel, Spanish mackerel, cobia, the blue shark and the shortfin mako shark. Again, as mentioned above, it is not unexpected that bluefin tuna, king mackerel, Spanish mackerel cobia, blue shark and shortfin mako shark were not observed because these species are pelagic and migratory and are not frequently collected in otter trawl sampling. Table 2 presents the results of the likelihood of occurrence analysis for the more demersal species with EFH designation for the fall and spring at the Proposed and alternative sites in Nantucket Sound. During the fall, the species that are generally common (very common, variably common and less common) include, black sea bass, butterfish, longfin squid, scup, summer flounder, and windowpane. In the spring, winter flounder, longfin squid windowpane, summer flounder, Atlantic cod, scup and black sea bass are generally common. Rare species include winter flounder and Atlantic surf clam in the fall and butterfish, Atlantic mackerel, Atlantic surf clam and shortfin squid in the spring. Atlantic cod, Atlantic mackerel and shortfin squid are not observed at all during the fall.

Table 3 presents those species with EFH designation that show potentially increasing or decreasing trends based on MDMF research trawl data over the 25-year period. In the fall, summer flounder and scup both appear to be increasing regionally. Black sea bass, windowpane and longfin squid appear to be decreasing in the region during the fall. Regionally during the spring, only Atlantic cod appears to be increasing. Black sea bass, windowpane, Atlantic surf clam and winter flounder appear to be decreasing. More detailed descriptions of how these analyses were conducted, as well as the other species included in the analysis, are presented in Appendix 5.4-A of the DEIS.

Table 2. Results of likelihood of occurrence analysis for species with EFH designation during the fall and spring at the Proposed and alternative sites in Nantucket Sound and regionally across sites

	Fall Site 1	Fall Site 2	Fall Site 3	Fall Regional
Very common	Black sea bass Butterfish Longfin squid Scup Summer flounder	Black sea bass Butterfish Longfin squid Scup Summer flounder	Black sea bass Butterfish Longfin squid Scup	Scup Longfin squid Butterfish Black sea bass Summer flounder
Variably common		Windowpane	Summer flounder	
Less common	Windowpane	Winter flounder	Windowpane	Windowpane
Rare	Winter flounder		Winter flounder	Winter flounder
Very rare	Atlantic surf clam		Atlantic sea herring	Atlantic surf clam
Not observed	Atlantic cod Atlantic mackerel Shortfin squid	Atlantic cod Atlantic mackerel Atlantic surf clam Atlantic sea herring Pollock Shortfin squid	Atlantic cod Atlantic mackerel Atlantic surf clam Shortfin squid	Atlantic cod Atlantic mackerel Shortfin squid

	Spring Site 1	Spring Site 2	Spring Site 3	Spring Regional
Very common	Longfin squid Summer flounder Windowpane Winter flounder	Longfin squid Windowpane Winter flounder	Longfin squid Summer flounder Windowpane Winter flounder	Winter flounder Longfin squid Windowpane
Variably common	Atlantic cod Black sea bass			Summer flounder
Less common	Butterfish Scup	Atlantic cod Black sea bass Butterfish Scup Summer flounder	Atlantic cod Butterfish	Atlantic cod Scup Black sea bass
Rare		Atlantic mackerel	Atlantic sea herring	Butterfish
Very rare	Atlantic mackerel Atlantic surf clam		Atlantic surf clam Shortfin squid	Atlantic mackerel Atlantic surf clam Shortfin squid
Not observed	Shortfin squid	Atlantic surf clam Atlantic sea herring Pollock Shortfin squid	Atlantic mackerel	

Note: Species were considered very common if they were caught greater than 75% of the time for a given season. Species caught between 50% and 75% of the time were considered variably common. Species caught between 25% and 50% of the time were considered less common. Species caught between 10% and 25% of the time were considered rare. Species caught greater than 0 and less than 10% of the time were considered very rare. The last category of occurrence was for those species not observed at all for a given site and season. Please refer to Appendix 5.4-A, Table 11 for more information.

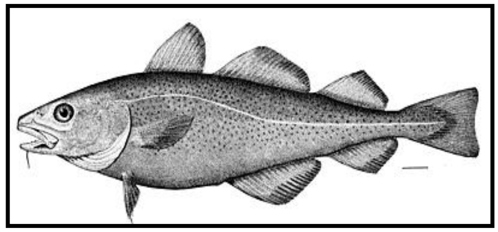
Table 3. Species potentially increasing or decreasing at the Proposed and alternative sites in Nantucket Sound and regionally, across sites

Fall							
Site 1		**Site 2**		**Site 3**		**Regional**	
Increasing	**Decreasing**	**Increasing**	**Decreasing**	**Increasing**	**Decreasing**	**Increasing**	**Decreasing**
Summer flounder	Black sea bass Windowpane	Summer flounder	Black sea bass	Butterfish Scup Summer flounder	Longfin squid	Scup Summer flounder	Black sea bass Longfin squid Windowpane
Spring							
Site 1		**Site 2**		**Site 3**		**Regional**	
Increasing	**Decreasing**	**Increasing**	**Decreasing**	**Increasing**	**Decreasing**	**Increasing**	**Decreasing**
Atlantic cod	Windowpane Winter flounder		Black sea bass		Windowpane	Atlantic cod	Atlantic surf clam Black sea bass Windowpane Winter flounder

3.3 Life History Characteristics of Species with EFH Designation

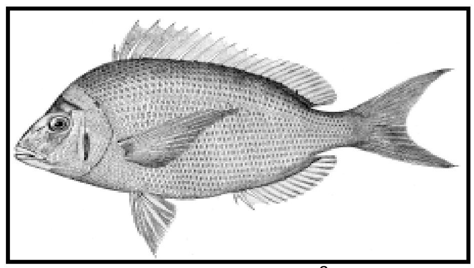
3.3.1 Demersal Species

ATLANTIC COD (*GADUS MORHUA*)



ADULTS. EFH for adult Atlantic cod is designated as those bottom habitats with substrates of rocks, pebbles, or gravel in the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Delaware Bay. Nantucket Shoals exists as a migration point for adults in the Mid-Atlantic Bight during summer and fall as southern water temperatures exceed 20°C (Heyerdahl and Livingstone 1982). MDMF trawl surveys (Fahay *et al.* 1999) in Massachusetts found adults occur more frequently in spring than in fall, but are rare for both seasons in Nantucket Sound. Consequently, the ELMR database indicates that adult cod are common in the Sound during the colder months, from October to April. In the spring, adult cod occur abundantly around Cape Ann, the tip of Cape Cod, and the western part of Cape Cod Bay. Few were found during fall, and those were restricted to the Cape Ann and Cape Cod tip areas. Adult cod are typically found on or near bottom along rocky slopes and ledges, preferring depths between 40-130 m, but are sometimes found at mid-water depths (Fahay *et al.* 1999). They can tolerate a temperature range from near freezing to 20°C, but prefer temperatures below 10°C (Fahay *et al.* 1999). Adult cod can also exist in a wide range of oceanic salinities. NMFS has designated all of Nantucket Sound as EFH for this life stage; however, impacts to adult cod habitat are expected to be minimal (see Section 4). Because adult cod are highly mobile, any individuals in the Project Area during construction or decommissioning would likely avoid or move from the area. No adverse impacts are expected during operation/maintenance.

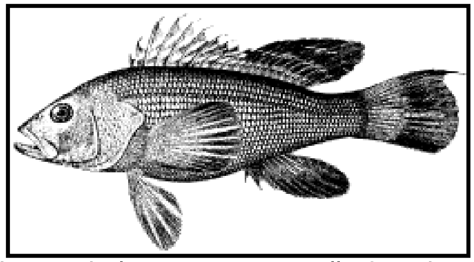
SCUP (*STENOTOMUS CHRYSOPS*)



JUVENILES. For juvenile scup, EFH is designated as the demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all estuaries and bays where juvenile scup were identified as being common, abundant or highly abundant in the ELMR database for the "mixing" (0.5-25.0 ppt) and "seawater" (>25 ppt) salinity zones between Massachusetts and Virginia, in association with various sands, mud, mussel, and eelgrass bed type substrates. Juveniles are common and highly abundant in Nantucket Sound from May to October as indicated in the ELMR database. As inshore water temperatures decline to less than 8-9°C in winter, scup leave inshore waters and move to warmer waters in the Mid-Atlantic Bight, returning inshore with rising temperatures in the spring (Steimle *et al.* 1999b). Juveniles will often use biogenic depressions, sand wave troughs, and possibly mollusk shell fields for shelter in winter (Steimle *et al.* 1999b). Generally, juvenile scup can be found in water temperatures greater than 7.2°C and in salinities greater than 15 ppt. Impacts to juvenile scup habitat due to activities from the Project are expected to be minimal (see Section 4). Additionally, because juvenile scup are mobile, any individuals within the Project Area during construction and decommissioning would likely avoid or move from the area. No adverse impacts are expected during operation/maintenance.

ADULTS. EFH for adult scup is designated as those demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all estuaries where adult scup were identified as being common, abundant or highly abundant in the ELMR database for the "mixing" (0.5-25.0 ppt) and "seawater" (>25 ppt) salinity zones. Adults are highly abundant in Nantucket Sound from May to September and common in October as indicated in the ELMR database. The distribution and abundance of adult scup off New England is temperature dependent (Mayo 1982; Gabriel 1992). As inshore water temperatures decline to less than 8-9°C in winter, scup leave inshore waters and move to warmer waters in the Mid-Atlantic Bight (Steimle *et al.* 1999b). Thus, wintering adults (November through April) are primarily offshore, south of New York to North Carolina relative to the location of the 7°C bottom isotherm, their lower preferred limit (Neville and Talbot 1964). With rising temperatures in the spring, scup return inshore (Steimle *et al.* 1999b). Off Massachusetts, surveys (MAFMC 1996a) showed that most adults were collected in spring through fall at depths less than 30 m. As with juveniles, impacts to adult scup habitat due to activities from the Project are expected to be minimal (see Section 4). Additionally, because adult scup are mobile, any individuals within the Project Area during construction and decommissioning would likely avoid or move from the area. No adverse impacts are expected during operation/maintenance.

BLACK SEA BASS (*CENTROPRISTIS STRIATA*)



LARVAE. For larval black sea bass, EFH is designated as the pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all the estuaries where larval black sea bass were identified as being common, abundant or highly abundant in the ELMR database for the "mixing" (0.5-25.0 ppt) and "seawater" (>25 ppt) salinity zones. Larval black sea bass are not yet compiled in the ELMR database. Based on New England Fisheries Science Center (NEFSC) MARMAP[1] ichthyoplankton surveys (Steimle *et al.* 1999a), larvae are generally found at water temperatures of 11-26^{o}C (*13-21^{o}C preferred range*). They were also collected at depths less than 100 m, but several collections during May-July and October occurred over deeper (>200 m) waters. The habitats for transforming (to juveniles) larvae are near the coastal areas and into marine parts of estuaries between New York and Virginia. Lower salinity estuarine waters are generally avoided. Studies (Steimle *et al.* 1999a) have reported larvae in high salinity areas of southern New England in August and September. When larvae become demersal, they are generally found on structured inshore habitat. Although impacts to larval sea bass habitat are expected to be minimal (see Section 4), if demersal larval stages are present during Project construction and decommissioning, some adverse impacts may occur (i.e., abrasion from suspended sediment or burial). Limited motility in the latter stages of larval development, however, may facilitate avoidance behaviors or movement from the area. No substantial impacts are expected during operation/maintenance.

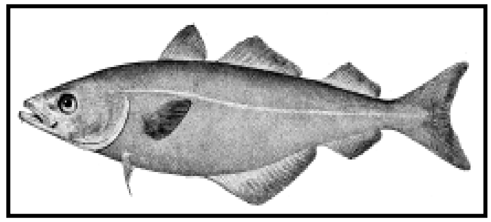
JUVENILES. The demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras, are designated as EFH for juvenile black sea bass. EFH in inshore waters includes all estuaries where juvenile black sea bass were identified as being common, abundant or highly abundant in the ELMR database for the "mixing" (0.5-25.0 ppt) and "seawater" (>25 ppt) salinity zones. Juveniles are common in Nantucket Sound from May to October as indicated in the ELMR database. Most juvenile settlement does not occur in estuaries, but in coastal areas (Steimle *et al.* 1999a). Recently settled juveniles then find their way into estuarine nurseries, where they will co-exist with other fish species in and around oyster beds (Steimle *et al.* 1999a). This is generally in the high salinity area (Mercer 1989) of most estuaries along the coast from southern Cape Cod to North Carolina (Steimle *et al.* 1999a). Older juveniles return to estuaries in late spring and early summer, and may follow the migration routes of adults into coastal waters (Steimle *et al.* 1999a). However, all juveniles seem to winter offshore, from New Jersey southward. Juvenile black sea bass are associated with rough and hardbottom substrate, shellfish and eelgrass beds, and man-made structures in sandy/shelly areas, as well as offshore clam beds and shell patches during the wintering. Some individuals may spend the warmer months along the coast in accumulations of surf clam and ocean quahog shells (Able *et al.* 1995). They are not common on open, unvegetated sandy intertidal flats or beaches (Allen *et al.* 1978). Juvenile black sea bass can be found mostly in water temperatures greater than 6.1^{o}C, but usually migrate to deeper, warmer waters when temperatures drop below 14^{o}C. The preferred salinity range is greater than 18 ppt. Impacts to juvenile black sea bass habitat due to activities from the Project are expected to be minimal (see Section 4). Additionally, because juvenile black sea bass are mobile, any individuals within the Project Area during construction and decommissioning would likely avoid or move from the area. No adverse impacts are expected during operation/maintenance.

ADULTS. EFH for adult black sea bass is also designated as those demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all estuaries where adult black sea bass were identified as being common, abundant or highly abundant in the ELMR database for the "mixing" (0.5-25.0 ppt) and "seawater" (>25 ppt) salinity zones. Adults are common in Nantucket Sound from May to October as indicated in the ELMR database. NEFSC spring surveys (Steimle *et al.* 1999a) in Massachusetts found adults were most common at bottom temperatures between 11-14^{o}C, and at depths less than 5 m. NEFSC fall surveys found them most often at bottom temperatures between 14-23^{o}C, and at depths less than 15 m. They were generally more abundant in the spring. Adult black sea bass can also be found in estuaries from May through October, although they prefer deeper bays and coastal waters (Steimle *et al.* 1999a). They are heavily associated with man-made structures, rough and hardbottom substrate along the sides of navigational channels (Steimle *et al.* 1999a), shellfish and eelgrass beds, and sandy/shelly areas. Adult black sea bass prefer water temperatures

[1] Marine Resources Monitoring, Assessment and Prediction

greater than 8.8°C.[2] Wintering adults are generally offshore, south of New York to North Carolina in water temperatures greater than 6.1°C and in association with sandy and shelly substrate. Studies (Mercer 1989) have found adult black sea bass to prefer depths of 20-60 m. Impacts to adult black sea bass habitat due to activities from the Project are expected to be minimal (see Section 4). Additionally, because adult sea bass are mobile, any individuals within the Project Area during construction and decommissioning would likely avoid or move from the area. No adverse impacts are expected during operation/maintenance.

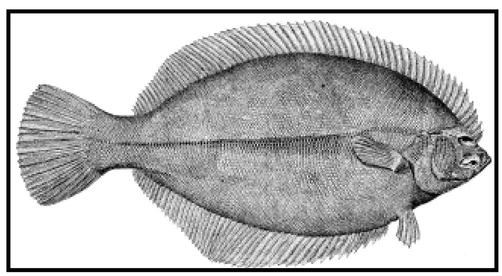
POLLOCK (*POLLACHIUS VIRENS*)



JUVENILES. Bottom habitats with aquatic vegetation or a substrate of sand, mud, or rocks in the Gulf of Maine or Georges Bank is considered EFH for juvenile pollock. EFH in inshore waters includes all estuaries and bays where juvenile pollock were identified as being common or abundant in the ELMR database for the "seawater" (>25 ppt) salinity zone. Juveniles are common to abundant in the northeastern corner of Nantucket Sound, near Monomoy Island, as identified by the fishing industry, inshore surveys, and the ELMR database.[3] Massachusetts inshore trawl surveys (1978-1996), as reported by Cargnelli *et al.* (1999d), show a spring concentration of juvenile pollock in the northeastern corner of Nantucket Sound and on the western shore of Martha's Vineyard. The fall concentrations of juveniles in this study were found off Cape Ann, MA and in Cape Cod Bay. The primary prey of juvenile pollock are crustaceans, but fish may play a more important role in their diet (Cargnelli *et al.* 1999d). Specifically, the Atlantic sea herring is the most important prey species of fish for juveniles (Cargnelli *et al.* 1999d). The inshore spring migrations of Atlantic sea herring seem to correlate with the concentration of juvenile pollock to the eastern edge of Nantucket Sound, and thus, their subsequent absence in fall. Generally, juvenile pollock can be found in water temperatures below 18°C, depths less than 250 m, and in a salinity range of 29-32 ppt. NMFS has not designated EFH for this species at the Proposed Alternative Site on Horseshoe Shoal, therefore no impacts are expected.

3.3.2 Demersal Groundfish Species

WINTER FLOUNDER (*PSEUDOPLEURONECTES AMERICANUS*)



EGGS. EFH for winter flounder eggs consists of bottom habitat with a substrate of sand, muddy sand, mud, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. However, sand appears to be the most common associated substrate (Pereira *et al.* 1999). Winter flounder eggs are not yet compiled in the ELMR database. Generally (with the exception of Georges Bank and Nantucket Shoals), winter flounder eggs can be found in water temperatures below 10°C, depths less than 5 m, and a salinity range between 10-30 ppt. The optimal salinity range for egg survival is between 15-35 ppt (Buckley 1989). Extremes in salinity may lower egg hatching success (Buckley 1989). The optimal temperature range for egg survival is between 0-10°C (Williams 1975). NMFS has appointed specific regions of EFH in the Project Area for this life stage, and eggs may be subject to random burial from settling sediment during construction and decommissioning activities. No adverse impacts are expected during operation and maintenance.

LARVAE. EFH for larval winter flounder is designated as pelagic and bottom waters of Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Winter flounder larvae are not yet compiled in the ELMR database. Generally, the following habitat conditions exist for larvae: sea surface temperatures below 15°C, depths less than 6 m, and a salinity range between 4-30 ppt. Extremes in salinity may lower larval survival success (Buckley 1989). NMFS has appointed specific regions of EFH in the Project Area for this life stage. Although impacts to larval winter flounder habitat are expected to be minimal (see Section 4),if more demersal larvae are present during Project construction and decommissioning, some adverse impacts may occur (i.e., abrasion from suspended sediment or burial). Limited motility in the latter

[2] http://www.jcaa.org/ASMFC/9801BLSB.htm
[3] http://www.nero.nmfs.gov/ro/doc/pollock.pdf

stages of larval development, however, may facilitate avoidance behaviors or movement from the area. No substantial impacts are expected during operation/maintenance.

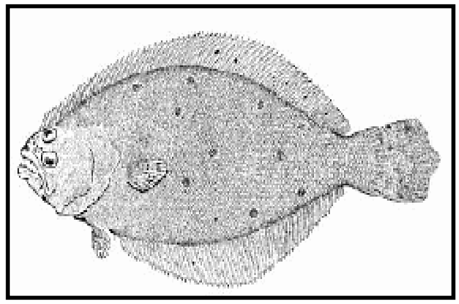
"*Young-of-the-Year" Juveniles*. Winter flounder less than one year old (Young-of-the-Year, or YOY) are treated separately for this species because their habitat requirements are different from that of larger juveniles (>1 yr.) (Pereira *et al.* 1999). EFH includes bottom habitat with a substrate of mud or sand on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to Delaware Bay. Many studies reviewed in Pereira *et al.* (1999) confirm young winter flounder are plentiful along the east coast, especially in Massachusetts. In southern New England, newly metamorphosized YOY juveniles take up residence in shallow water where they may grow to larger juvenile sizes within the first year (Bigelow and Schroeder 1953). Sandy coves appear to be the preferred habitat in the very shallow waters of estuaries and bays where they were spawned (Hildebrand and Schroeder 1928). However, recent comparisons of habitat-specific patterns of abundance and distribution of YOY winter flounder in many Mid-Atlantic estuaries support the conclusion that habitat utilization by YOY winter flounder is not consistent across habitat types and is highly variable among systems and from year to year (Pereira *et al.* 1999; Goldberg *et al.*, in prep). NEFSC bottom trawl surveys (Pereira *et al.* 1999) found YOY were most common in water temperatures below 28^{o}C (*18.5^{o}C preferred range*) (Casterlin and Reynolds 1982), depths from 0.1-10 m, and a salinity range between 5-33 ppt. NMFS has appointed specific regions of EFH in the Project Area for this life stage. Impacts to YOY winter flounder habitat due to activities from the Project are expected to be minimal (see Section 4). Additionally, because YOY winter flounder are mobile, any individuals within the Project Area during construction and decommissioning would likely avoid or move from the area. No adverse impacts are expected during operation/maintenance.

Age 1+ Juveniles. Winter flounder juveniles older than 1 year have EFH in bottom habitats with a substrate of mud or fine-grained sand on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Juveniles are common, abundant, and highly abundant throughout the year in Nantucket Sound as indicated in the ELMR database. Older juveniles inhabiting estuaries gradually move seaward as they grow larger (Mulkana 1966). NEFSC bottom trawl surveys (Pereira *et al.* 1999) found the majority of juveniles were at water temperatures of 4-7^{o}C in spring and 11-15^{o}C in fall. In general, water temperatures below 25^{o}C, depths from 1-50 m, and a salinity range between 10-30 ppt is preferred. NMFS has appointed specific regions of EFH in the Project Area for this life stage. As with YOY winter flounder, impacts to juvenile winter flounder habitat are expected to be minimal (see Section 4). High mobility of any individuals in the Project Area during construction or decommissioning activities would facilitate avoidance or movement from the area. No adverse impacts are expected during operation/maintenance.

Adults. EFH for adult winter flounder consists of bottom habitat, including estuaries, with a substrate of mud, sand, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Adults are common, abundant, and highly abundant throughout the year in Nantucket Sound as indicated in the ELMR database. Traditionally, New England and the New York Metropolitan area have contained the most abundant populations (NUSC 1989). NEFSC surveys (Pereira *et al.* 1999) in Massachusetts found adults were plentiful at water temperatures of 5-13^{o}C in spring and at 9-13^{o}C in the fall. Water temperature seems to be the most important factor determining seasonal distribution of adults (McCracken 1963). As a general rule, the warmer the water gets, the farther offshore winter flounder will migrate. Generally, adult winter flounder exist in water temperatures below 15^{o}C (*12-15^{o}C preferred range*) (McCracken 1963), depths from 1-100 m, and a salinity range between 15-33 ppt. MDMF (2001b) survey trawls on Horseshoe Shoal have found winter flounder are relatively common during spring and rare during fall within the Project Area. NMFS has appointed specific regions of EFH in the Project Area for this life stage. Impacts to adult winter flounder habitat due to activities from the Project are expected to be minimal (see Section 4). Additionally, because adult winter flounder are mobile, any individuals within the Project Area during construction and decommissioning would likely avoid or move from the area. No adverse impacts are expected during operation/maintenance.

Spawning Adults. For spawning winter flounder, EFH consists of bottom habitat, including estuaries, with a substrate of sand, mud, muddy sand, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Winter flounder adults undertake small-scale migrations into estuaries, embayments, and saltwater ponds from winter through spring to spawn. Winter flounder are most often observed spawning during the months of February to June with the peak spawning occurring during February and March south of Cape Cod (Goldberg *et al.*, in prep). Typically, eggs are deposited over a sandy substrate at depths of 2-80 m (Bigelow and Schroeder 1953), although most spawning takes place at depths less than 5 m. Major egg production occurs in New England waters before temperatures go below 3.3^{o}C (Bigelow and Schroeder 1953). Salinity preferences range from 31 to 32.5 ppt in inshore waters, and at slightly higher salinities between 32.7-33 ppt on Nantucket Shoals and Georges Bank (Bigelow and Schroeder 1953). After spawning, adults may remain in the spawning areas before moving to deeper waters when water temperatures reach 15^{o}C (McCracken 1963). NEFSC surveys (Pereira *et al.* 1999) in Massachusetts found the bulk of the adult catch occurred in water 25 m or less in the spring (during and just after spawning) and 25 m or deeper in the fall (prior to spawning). NMFS has appointed specific regions of EFH in the Project Area for this life stage. As mentioned above for adults, impacts to winter flounder habitat is expected to be minimal and high mobility of any individuals in the Project Area during construction and decommissioning would facilitate avoidance or movement from the area. Although spawning adults will likely avoid the area during these phases, the eggs resulting from spawned activities could be adversely impacted as mentioned above. No substantial impacts are expected during operation/maintenance.

SUMMER FLOUNDER, OR FLUKE (*PARALICHTHYS DENTATUS*)



EGGS. EFH for summer flounder eggs is designated as those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. Summer flounder eggs are not yet compiled in the ELMR database. Generally, summer flounder eggs are found between October and May, being most abundant between Cape Cod and Cape Hatteras, with the heaviest concentrations within 9 miles offshore of New Jersey and New York. Able *et al.* (1990) found the highest frequencies of occurrence and greatest abundances of eggs in the northwest Atlantic occur in October and November. Although, due to limited sampling in December south of New England, December could be under represented. Eggs are most often collected at depths of 30-70 m in the fall, as far down as 110 m in the winter, and from 10-30 m in the spring (Packer *et al.* 1999). Impacts to pelagic waters due to activities from the Project are expected to be minimal (see Section 4). Since summer flounder eggs are buoyant and pelagic, no substantial direct impacts are expected during construction, decommissioning or operation/maintenance activities.

LARVAE. The pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras, are designated as EFH for summer flounder larvae. EFH in inshore waters includes all the estuaries where larval summer flounder were identified as being present (rare, common, abundant or highly abundant) in the ELMR database for the "mixing" (0.5-25.0 ppt) and "seawater" (>25 ppt) salinity zones. Larvae are not yet compiled in the ELMR database. Larvae are generally most abundant nearshore (12-50 m from shore) at depths between 10-77 m. They are most frequently found in the northern part of the Mid-Atlantic Bight from September to February. Impacts to pelagic waters due to activities from the Project are expected to be minimal (see Section 4). Additionally in the latter stages of larval development some mobility may allow for avoidance or movement from the area during the construction and decommissioning activities. No substantial impacts are expected during operation/maintenance.

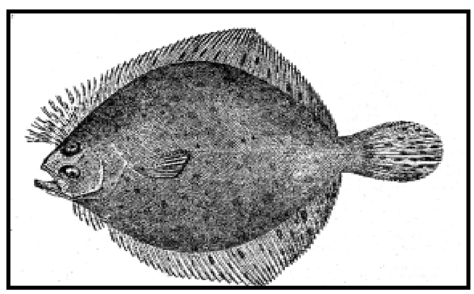
JUVENILES. EFH for juvenile summer flounder consists of the demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all estuaries where juvenile summer flounder were identified as being present (rare, common, abundant or highly abundant) in the ELMR database for the "mixing" (0.5-25.0 ppt) and "seawater" (>25 ppt) salinity zones. Juveniles are rare in Nantucket Sound from May to October as indicated by the ELMR database. In estuaries north of Chesapeake Bay, some juveniles remain in their estuarine habitat for 10-12 months before migrating offshore their second fall and winter (Packer *et al.* 1999). NEFSC surveys (Packer *et al.* 1999) in Massachusetts revealed a seasonal shift in juvenile occurrence with bottom temperature. In the spring, most juveniles occur at a range of temperatures from 9-14^{o}C, while in the fall they occur at temperatures from 15-21^{o}C. Generally, juvenile summer flounder use several different estuarine habitats as nursery areas, including salt marsh creeks, seagrass beds, mudflats, and open bay areas in a salinity range of 10-30 ppt. Impacts to juvenile summer flounder habitat due to activities from the Project are expected to be minimal (see Section 4). Additionally, because juvenile summer flounder are mobile, any individuals within the Project Area during construction and decommissioning would likely avoid or move from the area. No adverse impacts are expected during operation/maintenance.

ADULTS. Like juveniles, EFH for adult summer flounder also consists of the demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all estuaries where adult summer flounder were identified as being present (rare, common, abundant or highly abundant) in the ELMR database for the “mixing” (0.5-25.0 ppt) and “seawater” (>25 ppt) salinity zones. Adults are common in Nantucket Sound from May to October as indicated by the ELMR database. The preferred substrate is sand, which is used to conceal themselves from predators and thus avoid predation. Summer flounder in Massachusetts migrate inshore in early May and occur along the entire shoal area south of Cape Cod and Buzzards Bay, Vineyard Sound, Nantucket Sound, and the coastal waters around Martha’s Vineyard (Howe *et al.* 1997). MDMF considers the shoal waters of Cape Cod Bay and the region east and south of Cape Cod, including all estuaries, bays, and harbors thereof, as critically important habitat (Packer *et al.* 1999). All of these designated areas are outside of the Proposed and alternative sites in Nantucket Sound.

The salinity range of preference for adults appears to be greater than 15 ppt, and they are generally observed in the higher salinity portions of estuaries (Packer *et al.* 1999). However, studies by Burke (1991) and Burke *et al.* (1991) have made it clear that the summer flounder’s distribution is due to substrate preference and is not affected by salinity. Summer flounder occupy a variety of habitats over sand, mud, and vegetated substrate including marsh creeks (Able and Fahay 1998). Generally, adult summer flounder inhabit shallow coastal and estuarine waters during spring and summer, then move offshore during late summer and fall to the outer continental shelf to depths of 170 m. They occur in an extremely varied temperature range, between 2-27^{o}C (Packer *et al.* 1999). NEFSC surveys (Packer *et al.* 1999) in Massachusetts revealed a seasonal shift in adult occurrence with bottom temperature. In the spring, most adults occur at a range of temperatures from 6-17^{o}C, while in the fall they occur at temperatures from 14-21^{o}C. Tagging studies (Poole 1962; Lux and Nichy 1981) on flounder released off Long Island and southern New England revealed that adults usually began seaward migrations in September or October. Some evidence suggests that older adults may remain offshore all year (Festa 1977). Impacts to adult summer flounder habitat due to activities from the Project are expected to be minimal (see Section 4). Additionally, because adult summer flounder are mobile, any individuals within the Project Area during construction and decommissioning would likely avoid or move from the area. No adverse impacts are expected during operation/maintenance.

*Habitat Area of Particular Concern (EFH-HAPC) for summer flounder is defined as all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH. If native species of SAV are eliminated, exotic species should be protected because of functional value. However, all efforts should be made to restore native species.

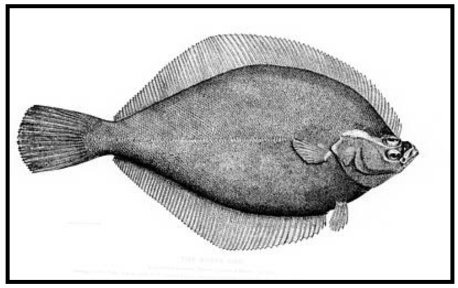
WINDOWPANE (*SCOPHTHALMUS AQUOSUS*)



ADULTS. For adult windowpane, EFH exists in bottom habitats with a substrate of sand, fine-grained sand, or mud around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south to the Virginia-North Carolina border. Adults are common and abundant in Nantucket Sound throughout the year as indicated by the ELMR database. Adults occur primarily on sand substrates off southern New England (Chang *et al.* 1999). NEFSC surveys (Chang *et al.* 1999) in Massachusetts revealed most adults were caught south of Cape Cod during spring at bottom temperatures of 9-13^{o}C and at depths less than 15 m. This high aggregation in spring suggests spawning or feeding activities. In fall, adults were more widely distributed across this range, preferring bottom temperatures of 9-19^{o}C and depths less than 30 m. Generally, adult windowpane can be found in water temperatures below 26.8^{o}C, depths of 1-100 m, and a salinity range between 5.5-36 ppt. MDMF (2001b) survey trawls on Horseshoe Shoal have found windowpane are relatively common during spring and rare during fall within the Project Area. NMFS has appointed specific regions of EFH in the Project Area for this life stage. Impacts to windowpane habitat due to activities from the Project are expected to be minimal (see Section 4). Additionally, because windowpane are mobile, any individuals within the Project Area during construction and decommissioning would likely avoid or move from the area. No adverse impacts are expected during operation/maintenance.

SPAWNING ADULTS. Spawning windowpane have designated EFH in bottom habitats with a substrate of mud or fine-grained sand in the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. A high aggregation of adults south of Cape Cod in spring suggests spawning activities in the Project Area (Chang *et al.* 1999). Generally, the following habitat conditions for spawning adults exist: water temperatures below 21°C, depths from 1-75 m, and a salinity range between 5.5-36 ppt. The seabed sediment composition of Nantucket Sound primarily consists of sand. Since the preference for spawning adults is fine-grained sand or mud, spawning activities may not occur in the Project Area. This is substantiated by NMFS not designating EFH in the Project Area for eggs. If spawning adults were present, their high mobility would facilitate avoidance or movement from the area during construction and decommissioning activities. No substantial impacts would be expected, although previously deposited eggs could be affected by Project construction or decommissioning depending on location. No adverse impacts are expected during operation/maintenance.

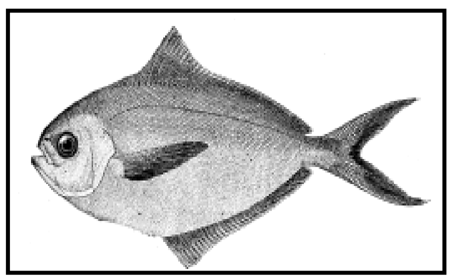
YELLOWTAIL FLOUNDER (*LIMANDA FERRUGINEA*)



JUVENILES. EFH for juvenile yellowtail flounder is not present in Nantucket Sound. EFH for juvenile yellowtail flounder is designated as bottom habitat with a substrate of sand or sand/mud on Georges Bank, the Gulf of Maine, and the southern New England shelf south to Delaware Bay. Juveniles are rare and absent from Nantucket Sound throughout the year as indicated by the ELMR database. The concentration of juvenile yellowtail flounder is seasonal in coastal waters east of Cape Cod, with small numbers caught in the shoal waters south of Martha's Vineyard and Nantucket Island (Johnson *et al.* 1999). MDMF trawl surveys found the highest concentration of juveniles at temperatures ranging from 2-14°C (*4-8°C preferred range*) in spring and 5-17°C (*8-11°C preferred range*) in fall; depths ranged from 5-75 m (Johnson *et al.* 1999). Despite the seasonal aggregation of juveniles in the northern Cape Cod area (Cape Cod Bay) during spring and fall, they migrate away from coastal areas during the latter half of the fall season (Johnson *et al.* 1999). Juveniles can also be found in a salinity range from 32.4-33.5 ppt. According to more site-specific EFH assessments, NMFS has not appointed specific regions of EFH in Nantucket Sound for this life stage[4], therefore no substantial impacts are expected.

3.3.3 Coastal Pelagic Species

ATLANTIC BUTTERFISH (*PEPRILUS TRIACANTHUS*)



EGGS. EFH for butterfish eggs is designated as those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the "mixing" (0.5-25.0 ppt) and "seawater" (>25 ppt) portions of all estuaries where Atlantic butterfish eggs were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Atlantic butterfish eggs are not yet compiled in the ELMR database, but are considered common in Massachusetts Bay, Cape Cod Bay, Waquoit Bay, and Buzzards Bay (Cross *et al.* 1999). Generally, eggs are found in water temperatures of 11.1-17.2°C and from shore to 2000 m, but concentrated in depths less than 200 m. Impacts to pelagic waters from the Project are expected to be minimal (see Section 4). Because butterfish eggs are buoyant and pelagic (Cross *et al.* 1999), no substantial impacts are expected during construction, decommissioning or operation/maintenance activities.

LARVAE. EFH for Atlantic butterfish larvae consists of those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH for inshore waters includes the "mixing" (0.5-25.0 ppt) and "seawater" (>25 ppt) portions of all the estuaries where Atlantic butterfish larvae were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Atlantic butterfish eggs are not yet compiled in the ELMR database, but are considered common in Buzzards Bay and Waquoit Bay (Cross *et al.* 1999). During the NEFSC MARMAP ichthyoplankton surveys (Cross *et al.* 1999), butterfish larvae were mostly found at water temperatures of 9-19°C, depths less than 120 m, and at salinities ranging from estuarine to full strength seawater. Impacts to pelagic waters from the Project are expected to be

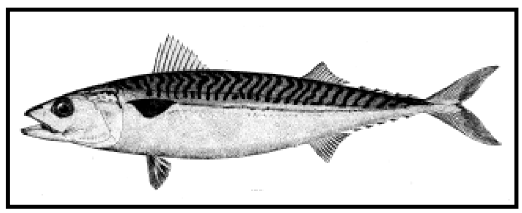
[4] www.nero.nmfs.gov/ro/doc/yellowtail.pdf

minimal (see Section 4). Additionally in the latter stages of larval development some mobility may allow for avoidance or movement from the area during the construction and decommissioning activities. No substantial impacts are expected during operation/maintenance.

JUVENILES. EFH for juvenile butterfish is designated as those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the "mixing" (0.5-25.0 ppt) and "seawater" (>25 ppt) portions of all the estuaries where juvenile Atlantic butterfish were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Juveniles are abundant in Nantucket Sound from June to October, and common in November as indicated by the ELMR database. During NEFSC surveys (Cross *et al.* 1999) in Massachusetts, butterfish juveniles were found at depths ranging from 5-80 m, but most were collected between 10-35 m. Bottom water temperatures ranged from 9-15^{o}C in the spring and 7-22^{o}C in the fall. The surveys also revealed that juvenile catches were 1-2 times greater in fall than in spring. Impacts to pelagic waters from the Project are expected to be minimal (see Section 4). Additionally, because juvenile butterfish are mobile, any individuals within the Project Area during construction and decommissioning would likely avoid or move from the area. No adverse impacts are expected during operation/maintenance.

ADULTS. EFH for adult butterfish also consists of the pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the "mixing" (0.5-25.0 ppt) and "seawater" (>25 ppt) portions of all the estuaries where adult Atlantic butterfish were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Adults are abundant in Nantucket Sound from June to October, and common in May and November as indicated by the ELMR database. NEFSC surveys (Cross *et al.* 1999) in Massachusetts revealed adults were found at depths ranging from 5-80 m, but most were collected between 10-50 m. Bottom water temperatures ranged from 9-15^{o}C in the spring and 7-22^{o}C in the fall. In the spring, adults were caught primarily south of Cape Cod and in Buzzards Bay, while in fall they were caught primarily in Buzzards Bay, Massachusetts Bay, and around Cape Ann. Several studies in Cross *et al.* (1999) also reveal adults will inhabit the high salinity and mixed salinity zones of most estuaries from the Gulf of Maine to Florida. MDMF (2001b) survey trawls on Horseshoe Shoal have found butterfish are rare during spring and more common during fall within the Project Area. Impacts to pelagic waters from the Project are expected to be minimal (see Section 4). Additionally, because adult butterfish are mobile, any individuals within the Project Area during construction and decommissioning would likely avoid or move from the area. No adverse impacts are expected during operation/maintenance.

ATLANTIC MACKEREL (*SCOMBER SCOMBRUS*)



EGGS. EFH for Atlantic mackerel eggs is designated as those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the "mixing" (0.5-25.0 ppt) and "seawater" (>25 ppt) portions of all the estuaries where Atlantic mackerel eggs were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Atlantic mackerel eggs are not yet compiled in the ELMR database. Eggs are pelagic in waters over 34 ppt (Fritzsche 1978). They can generally be found in water temperatures between 5-22.7^{o}C and at depths of 30-70 m. Yet, based on a Massachusetts coastal zone survey in Studholme *et al.* (1999), eggs in Nantucket Sound occur only randomly. Because impacts to pelagic waters from the Project are expected to be minimal, in the event that Atlantic mackerel eggs are present in the Project Area during construction, decommissioning, and operation/maintenance activities, they would not incur substantial impacts because of their pelagic and buoyant nature.

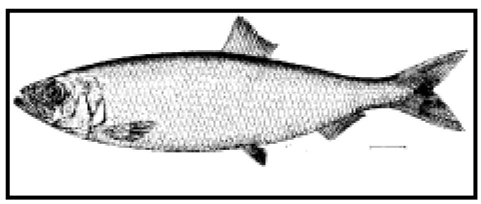
LARVAE. EFH for Atlantic mackerel larvae is also designated as those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the "mixing" (0.5-25.0 ppt) and "seawater" (>25 ppt) portions of all the estuaries where larval Atlantic mackerel were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Atlantic mackerel larvae are not yet compiled in the ELMR database. They can generally be found in water temperatures between 6.1-22.2^{o}C and at depths of 11-142 m. Yet, based on a Massachusetts coastal zone survey in Studholme *et al.* (1999), larvae in Nantucket Sound occur only randomly. Because impacts to pelagic waters from the Project are expected to be minimal, in the event that Atlantic mackerel larvae are present in the

Project Area during construction, decommissioning, and operation/maintenance activities, they would not incur substantial impacts. Additionally later stage larvae may be capable of some mobility and will avoid or move from the area.

JUVENILES. EFH for juvenile Atlantic mackerel is designated as those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the "mixing" (0.5-25.0 ppt) and "seawater" (>25 ppt) portions of all the estuaries where juvenile Atlantic mackerel were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Juveniles are common in Nantucket Sound from August to November as indicated by the ELMR database. NEFSC surveys (Studholme *et al.* 1999) in Massachusetts revealed juveniles were most abundant at 11°C in spring and 9-13°C in fall, at depths of 10 and 50 m in spring and 25 and 60 m in fall. Occurrences of juvenile Atlantic mackerel were highest in the fall (Studholme *et al.* 1999). Yet, based on a Massachusetts coastal zone survey in Studholme *et al.* (1999), juveniles in Nantucket Sound occur only randomly. Impacts to pelagic waters from the Project are expected to be minimal (see Section 4). Additionally, because juveniles are mobile, any individuals within the Project Area during construction and decommissioning would likely avoid or move from the area. No adverse impacts are expected during operation/maintenance.

ADULTS. For adult Atlantic mackerel, EFH is also designated as those pelagic waters found over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the "mixing" (0.5-25.0 ppt) and "seawater" (>25 ppt) portions of all the estuaries where adult Atlantic mackerel were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Adults are common in Nantucket Sound in March, April, and from October to December as indicated by the ELMR database. Based on NEFSC surveys (Studholme *et al.* 1999) in Massachusetts, adults were most abundant at 14°C water temperatures during the spring, with only a few recorded in the fall at 10 and 15°C. Individuals in spring were caught at depths of 10 m while the few in fall were caught at 50 m. Yet, based on a Massachusetts coastal zone survey in Studholme *et al.* (1999), adults in Nantucket Sound occur only randomly. Impacts to pelagic waters from the Project are expected to be minimal (see Section 4). Additionally, because adult Atlantic mackerel are highly mobile, any individuals within the Project Area during construction and decommissioning would likely avoid or move from the area. No adverse impacts are expected during operation/maintenance.

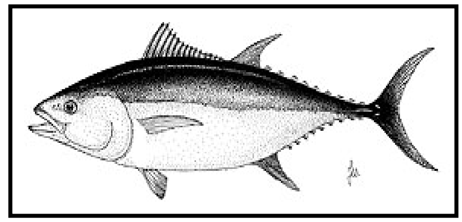
ATLANTIC SEA HERRING (*CLUPEA HARENGUS*)



JUVENILES. For juvenile Atlantic sea herring, EFH is designated as those pelagic waters and bottom habitats in the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. EFH in inshore waters includes all estuaries and bays where juvenile Atlantic sea herring were identified as being common or abundant in the ELMR database for the "mixing" (0.5-25.0 ppt) and "seawater" (>25.0 ppt) salinity zones. Juveniles form large schools in coastal waters throughout the Gulf of Maine and off southern New England (Reid *et al.* 1999a). In the summer and fall, juveniles move from nearshore waters to overwinter in deep bays or near bottom in offshore areas (Reid *et al.* 1999a). Some juveniles spend at least the spring and early summer off southern New England, especially off southern Massachusetts (through at least mid-June) before moving into the Gulf of Maine or offshore, presumably east of Cape Cod (Reid *et al.* 1999a). According to the Massachusetts inshore trawl surveys (1978-1996), as reported by Reid *et al.* (1999a), juveniles in spring were most abundant northwest of Cape Ann, throughout Cape Cod Bay, along the northern shore of Nantucket Island and southern shore of Martha's Vineyard, and Buzzard's Bay. Juveniles were also found to a lesser degree in the northeast corner of Nantucket Sound near Monomoy Island and off the south shore of Dennis, MA. In the fall, the largest catches of juveniles occurred around Cape Ann, in central and western Cape Cod Bay, off Buzzard's Bay, and off the southern shore of Martha's Vineyard. Generally, juvenile Atlantic sea herring can be found in water temperatures below 10°C, depths from 15-135 m, and in a salinity range of 26-32 ppt. NMFS has not designated EFH for this species at the Proposed Alternative Site on Horseshoe Shoal, therefore no impacts are expected.

3.3.4 Coastal Migratory Pelagic Species

BLUEFIN TUNA (*THUNNUS THYNNUS*)
EFH is not present for the designated lifestages of bluefin tuna in the Project Area; however, a brief summary of the location of EFH for each lifestage is provided below.

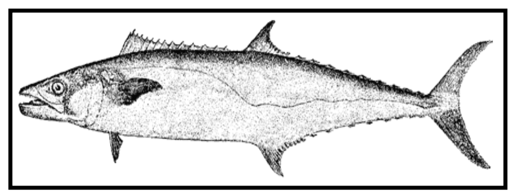


JUVENILES/SUBADULTS. EFH for juvenile/subadult bluefin tuna consists of all inshore and pelagic waters warmer than 12°C off the Gulf of Maine and Cape Cod Bay, from Cape Ann, MA (~42.75°N) east to 69.75°W, continuing south to and including Nantucket Shoals at 70.5°W to Cape Hatteras (~35.5°N), in pelagic surface waters warmer than 12°C, between the 25 and 200 m isobaths. EFH is not located in the Project Area.

ADULTS. Adult bluefin tuna are found from Newfoundland to Brazil,[5] but have EFH in the pelagic waters of the Gulf of Maine from the 50 m isobath to the EEZ boundary, including the Great South Channel, then south of Georges Bank to 39°N from the 50 m isobath to the EEZ boundary. EFH is not located in the Project Area.

**The general NMFS EFH designation[6] for the remaining Coastal Migratory Pelagic Species listed below includes the sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, but from the Gulf Stream shoreward (including* Sargassum*), coastal inlets, and tidal estuaries. In addition, all coastal inlets in the South and Mid-Atlantic Bight are state-designated nursery habitats of particular importance to these species as well. However, the following species do not have a management plan in the North Atlantic, and are currently managed within the jurisdiction of the South Atlantic Fisheries Management Council. All are considered rare in Nantucket Sound, as their preference lies in warmer waters south of Chesapeake Bay. Therefore, no specific EFH designations exist within the Project Area and no impacts are expected. More specific habitat characteristics taken from literature review and desktop analyses are described below:*

KING MACKEREL (*SCOMBEROMORUS CAVALLA*)[7]



EGGS. Studies in Godcharles and Murphy (1986) reveal that king mackerel spawn in the coastal waters of the northern Gulf of Mexico, and off the southern Atlantic coast. There does not appear to be a well-defined area for spawning, but warm waters are preferred. There is no documentation found of king mackerel eggs occurring at any regularity within the Project Area, which has physical properties that are inconsistent with its preferred habitat characteristics.

LARVAE. King mackerel larvae have been collected near the surface on the Atlantic coast from May through October in surface water temperatures of 26-31°C and in a salinity range of 26-37 ppt (Godcharles and Murphy 1986). Larval distribution indicates that spawning occurs in the western Atlantic off the Carolinas, Cape Canaveral and Miami, Florida. There does not appear to be a well-defined area for spawning. There is no documentation found of king mackerel larvae occurring at any regularity within the Project Area, which has physical properties that are inconsistent with its preferred habitat characteristics.

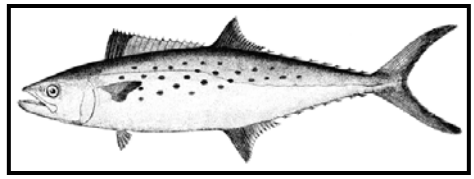
JUVENILES. There is no documentation found of juvenile king mackerel occurring at any regularity within the Project Area, which has physical properties that are inconsistent with its preferred habitat characteristics. Random individuals in the Sound would exhibit high motility, facilitating disturbance avoidance during construction.

ADULTS. King mackerel adults range from the Gulf of Maine to Rio de Janeiro, Brazil. However, they are most commonly found from the Chesapeake Bay southward. Migratory patterns are driven heavily by water temperature, preferring those greater than 20°C. There is no documentation found of adults occurring at any regularity within the Project Area, which has physical properties that are inconsistent with its preferred habitat

[5] http://www.cnie.org/nle/mar-5.html
[6] http://www.nero.nmfs.gov/ro/doc/list.htm
[7] http://www.chesapeakebay.net/info/spanish_mackerel.cfm

characteristics. Random individuals in the Sound would exhibit high motility, facilitating disturbance avoidance during construction.

SPANISH MACKEREL (*SCOMBEROMORUS MACULATUS*) [8]



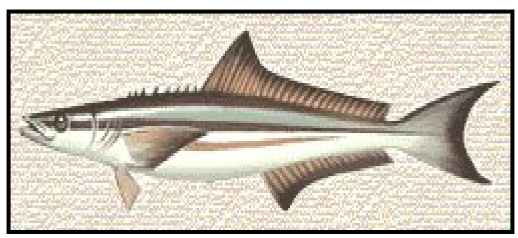
EGGS. All life stages of Spanish mackerel are primarily seen in waters above 17.7°C and within a salinity range of 32-36 ppt (Godcharles and Murphy 1986). There is no documentation found of Spanish mackerel eggs occurring at any regularity within the Project Area, which has physical properties that are inconsistent with its preferred habitat characteristics.

LARVAE. Larvae are generally found in surface water temperatures of 19.6-29.8°C and in a high salinity range of 28.3-37.4 ppt or higher.[9] There is no documentation found of larval Spanish mackerel occurring at any regularity within the Project Area, which has physical properties that are inconsistent with its preferred habitat characteristics.

JUVENILES. Apparently, some juvenile Spanish mackerel use estuaries as nursery grounds, but most stay nearshore in open beach waters (Godcharles and Murphy 1986). The waters surrounding the mouths of freshwater rivers are most often avoided.[10] All life stages of Spanish mackerel are primarily seen in waters above 17.7°C and within a salinity range of 32-36 ppt (Godcharles and Murphy 1986). There is no documentation found of juvenile Spanish mackerel occurring at any regularity within the Project Area, which has physical properties that are inconsistent with its preferred habitat characteristics. Random individuals in the Sound would exhibit high motility, facilitating disturbance avoidance during construction.

ADULTS. Spanish mackerel adults range from the Gulf of Maine to the Yucatan Peninsula, but are considered uncommon north of the Chesapeake Bay.[11] Migratory patterns are driven by water temperature, preferring a range of 21.1-31.1°C. All life stages of Spanish mackerel are primarily seen in waters above 17.7°C and within a salinity range of 32-36 ppt (Godcharles and Murphy 1986). They will spawn off Virginia over a long period between late spring and late summer. There is no documentation found of adult Spanish mackerel occurring at any regularity within the Project Area, which has physical properties that are inconsistent with its preferred habitat characteristics. Random individuals in the Sound would exhibit high motility, facilitating disturbance avoidance during construction.

COBIA (*RACHYCENTRON CANADUM*) [12]



EGGS. Most cobia eggs are found in offshore waters adjacent to the mouth of the Chesapeake Bay and south to Virginia in late June through mid-August (Shaffer and Nakamura 1989). There is no documentation found of cobia eggs occurring at any regularity within the Project Area, which has physical properties that are inconsistent with its preferred habitat characteristics.

LARVAE. Most cobia larvae are found in offshore waters adjacent to the mouth of the Chesapeake Bay and south to Virginia (Shaffer and Nakamura 1989) where they may inhabit the sargassum. There is no documentation found of cobia larvae occurring at any regularity within the Project Area, which has physical properties that are inconsistent with its preferred habitat characteristics.

JUVENILES. Studies in Shaffer and Nakamura (1989) show early juvenile cobia will move inshore and inhabit coastal areas, near beaches, river mouths, barrier islands, lower reaches of bays and inlets, or bays of relatively high salinities. Yet there is no documentation found of cobia juveniles occurring at any regularity within the Project Area, which has physical properties that are inconsistent with its preferred habitat characteristics.

[8] http://www.chesapeakebay.net/info/spanish_mackerel.cfm
[9] http://www.fishbase.org/search.cfm
[10] http://fwie.fw.vt.edu/WWW/macsis/lists/TSNL0105.htm
[11] http://www.hudsonriver.com/almanac/0997alm.htm
[12] http://www.vims.edu/adv/cobia/

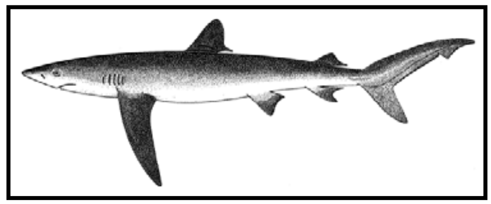
Random individuals in the Sound would exhibit high motility, facilitating disturbance avoidance during construction.

ADULTS. Cobia adults range from Cape Cod to Argentina. They undergo extensive migrations from overwintering grounds near the Florida Keys to more northerly spawning/feeding grounds in spring and summer months (Richards 1967). Cobia can be found in high salinity bays, estuaries, and seagrass habitat in a variety of locations over mud, gravel, or sand bottoms, coral reefs, and man-made sloughs. They often congregate along reefs and around buoys, pilings, wrecks, anchored boats, and other stationary or floating objects. There is no documentation found of adult cobia occurring at any regularity within the Project Area, which has physical properties that are inconsistent with its preferred habitat characteristics. Random individuals in the Sound would exhibit high motility, facilitating disturbance avoidance during construction.

3.3.5 Sharks

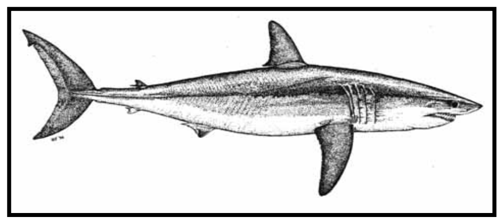
**The following shark species will most likely be rare around the Project Area due to their preference for deeper waters outside of Nantucket Sound. Because of their solitary pelagic nature, impacts to any shark individuals or their respective populations are not expected. Personal communications with the NMFS office in Gloucester, Massachusetts indicated that shark species EFH is located more offshore on the outer continental shelf, outside of Nantucket Sound.*

BLUE SHARK (*PRIONACE GLAUCA*)



ADULTS. Blue shark adults inhabit the pelagic, surface waters of tropical, subtropical, and temperate oceans worldwide. They are commonly found in the Cape Cod area during the summer months,[13] moving out to deeper water in late fall and winter.[14] Generally, blue sharks can be found in a temperature range of 7-27°C (*prefer 13-18°C*) and depths from 2-200 m.[15] Blue sharks are not expected to occur within the Project Area. In addition, their high motility would facilitate disturbance avoidance during construction; therefore, no substantial impacts are expected.

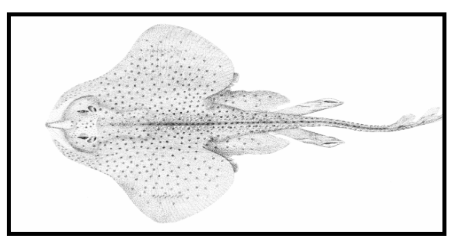
SHORTFIN MAKO SHARK (*ISURUS OXYRHINCHUS*)



LATE JUVENILES/SUBADULTS. EFH exists for juvenile shortfin mako sharks in the offshore waters between Cape Cod and Onslow Bay, NC, between the 25 and 2000 m isobaths; and extending west between 38°N and 41.5°N to the EEZ boundary. It is most commonly seen in offshore waters from Cape Cod to Cape Hatteras.[16] Generally, shortfin mako sharks are found in a temperature range between 17-20°C [7] and at depths from the surface to at least 150 m.[5] Shortfin mako sharks are not expected to occur within the Project Area. In addition, their high motility would facilitate disturbance avoidance during construction; therefore, no substantial impacts are expected.

3.3.6 Skates

LITTLE SKATE (*LEUCORAJA ERINACEA*) [17]



JUVENILES. EFH for juvenile little skate has been designated for the areas of highest relative abundance for this species based on NMFS trawl survey (1963-1999) and ELMR data. Only habitats with sandy, gravelly, or mud substrates that occur within these areas of high abundance are designated as EFH.[18] Skates are known to remain buried in depressions during the day and are more active at night.

[13] http://www.newenglandsharks.com/blue.htm
[14] http://www.mar.dfo-mpo.gc.ca/science/csas/status/1996/96_034e.html
[15] http://animaldiversity.ummz.umich.edu/accounts/prionace/p._glauca$narrative.html
[16] http://www.flmnh.ufl.edu/fish/Gallery/Descript/ShortfinMako/Shortfinmako.html
[17] http://www.nefsc.noaa.gov/nefsc/publications/tm/tm175/tm175.pdf
[18] http://www.nero.noaa.gov/ro/doc/skateefhmaps.htm

NEFSC bottom trawl surveys conducted between 1963 and 2002 (Reid *et al.*, 1999b) captured juvenile little skate year-round and showed that in the winter, juveniles were found from Georges Bank to Cape Hatteras, out to the 200 m depth contour, but were almost entirely absent from the Gulf of Maine. In spring they were also found from Georges Bank to Cape Hatteras, but were also heavily concentrated nearshore throughout the Mid-Atlantic Bight and southern New England as well as in Cape Cod and Massachusetts Bays. Both the spring and fall 1978-2002 Massachusetts inshore trawl surveys (Reid *et al.*, 1999b) show nearly identical abundances and distributions of juveniles around Nantucket and in Nantucket Sound, in Cape Cod Bay, along the Massachusetts coast and Broad Sound, and north of Cape Ann, with higher concentrations west and south of Martha's Vineyard. Along the inshore edge of its range, little skate moves onshore and offshore seasonally. They generally move into shallow water during the spring and into deeper water in the winter and may leave some estuaries for deeper water during warmer months.

Based on the Massachusetts spring and fall inshore trawl surveys (Reid *et al.*, 1999b), juvenile little skate were found at depth ranges between 1 and 65m, with most occurring between 6 and 25m during both seasons. In the spring, juveniles were found in waters ranging from 3-16^{o}C, with the greatest percentages between 8-12^{o}C. In the fall, they were found in waters ranging from 5-22^{o}C, with the highest percentages between 16-18^{o}C. NEFSC bottom trawl surveys (Reid *et al.*, 1999b) indicated that juvenile little skate were found at salinities ranging from 26-36 ppt, with the majority between 32-33 ppt during both spring and fall. Impacts to juvenile little skate habitat due to activities from the Project are expected to be minimal (see Section 4). Additionally, because little skate juveniles are mobile, any individuals within the Project Area during construction and decommissioning would likely avoid or move from the area. Those skates that are buried and inactive during the day may experience higher levels of injury or mortality; however, no measurable effects on populations would be expected. No adverse impacts are expected during operation/maintenance.

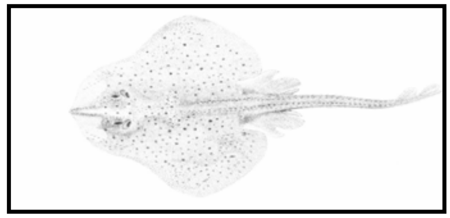
ADULTS. EFH for adult little skate has been designated for the areas of highest relative abundance for this species based on NMFS trawl survey (1963-1999) and ELMR data. Only habitats with sandy, gravelly, or mud substrates that occur within these areas of high abundance are designated as EFH.[18] Skates are known to remain buried in depressions during the day and are more active at night.

NEFSC bottom trawl surveys (Reid *et al.*, 1999b) captured adult little skate during all seasons. The numbers of adults in spring and fall were much lower than for juveniles of the same two seasons. In winter, they were caught from Georges Bank to North Carolina, with very few in the Gulf of Maine. In spring they were also found from Georges Bank to North Carolina and, as with the juveniles, were also distributed nearshore throughout the Mid-Atlantic Bight and along Long Island as well as in Cape Cod and Massachusetts Bays. They had a limited distribution in the summer, being found mostly in southern New England, Georges Bank, Cape Cod Bay, in the Gulf of Maine near Penobscot Bay, and near Browns Bank and the Northeast Channel. The distributions of adult little skate from both the spring and fall Massachusetts inshore trawl surveys (Reid *et al.*, 1999b) were similar to that of the juveniles, but with fewer numbers collected in all areas (including west and south of Martha's Vineyard).

Based on the Massachusetts spring and fall inshore trawl surveys (Reid *et al.*, 1999b), adult little skate were found at depth ranges between 1 and 75m, with most occurring between 6 and 30m in the spring and between 6 and 25m in the fall. In the spring, adults were found in waters ranging from 3-16^{o}C, with the majority occurring between 5-12^{o}C. In the fall, they were found in waters ranging from 5-21^{o}C, with peaks occurring at 10^{o}C and 16^{o}C. NEFSC bottom trawl surveys (Reid *et al.*, 1999b) indicated that adult little skate were found at salinities ranging from 29-36 ppt, with the majority occurring at 33 ppt in the spring and between 32-33 ppt in the fall. Impacts to adult little skate habitat due to activities from the Project are expected to be minimal (see Section 4). Additionally, because little skate adults are mobile, any individuals within the Project Area during construction and decommissioning would likely avoid or move from the area. Those skates that are buried and inactive during the day may experience higher levels of injury or mortality; however, no measurable effects on populations would be expected. No adverse impacts are expected during operation/maintenance.

WINTER SKATE (*LEUCORAJA OCELLATA*) [19]

[19] http://www.nefsc.noaa.gov/nefsc/publications/tm/tm179/tm179.pdf



JUVENILES. EFH for juvenile winter skate has been designated for the areas of highest relative abundance for this species based on NMFS trawl survey (1963-1999) and ELMR data. Only habitats with a substrate of sand and gravel or mud that occur within these areas of high abundance are designated as EFH.[18] Skates are known to remain buried in depressions during the day and are more active at night.

NEFSC bottom trawl surveys conducted between 1963 and 2002 (Reid *et al.*, 1999b) captured juvenile winter skate year-round. In winter, juveniles were found from Georges Bank to Cape Hatteras, out to the 200 m depth contour, but were almost entirely absent from the Gulf of Maine. In spring they were also found from Georges Bank to Cape Hatteras, and were concentrated nearshore throughout the Mid-Atlantic Bight and southern New England as well as in Cape Cod and Massachusetts Bays. Comparatively few were present in summer, with concentrations on Georges Bank and around Cape Cod. Winter skate abundances in the fall were not as high as in the spring. In the fall they were collected from Georges Bank to the Delmarva Peninsula and were again concentrated along Long Island, southern New England, around Cape Cod, and on Georges Bank. Both the spring and fall 1978-2002 Massachusetts inshore trawl surveys (Reid *et al.*, 1999b) show similar abundances and distributions of juveniles. The highest concentrations were found on the Atlantic side of Cape Cod and south and west of Martha's Vineyard (especially in spring) and south and northeast of Nantucket (also in spring). Large numbers were also found near Monomy Point in the fall. Other notable occurrences of winter skate were around Plum Island, Ipswich Bay, north of Cape Ann, near Nahant Bay (especially in the fall), in Cape Cod Bay, and in Nantucket Sound.

Based on the Massachusetts spring and fall inshore trawl surveys (Reid *et al.*, 1999b), juvenile winter skate were found at depth ranges between 1 and 75m, with most occurring between 6 and 25m during both seasons. In the spring, juveniles were found in waters ranging from 3-15^{o}C, with the greatest percentages between 8-12^{o}C. In the fall, they were found in waters ranging from 5-21^{o}C, with peak occurrences between 16-18^{o}C. NEFSC bottom trawl surveys (Reid *et al.*, 1999b) indicated that juvenile winter skate were found at salinities ranging from 28-35 ppt, with the majority between 32-33 ppt during both spring and fall. Impacts to juvenile winter skate habitat due to activities from the Project are expected to be minimal (see Section 4). Additionally, because winter skate juveniles are mobile, any individuals within the Project Area during construction and decommissioning would likely avoid or move from the area. Those skates that are buried and inactive during the day may experience higher levels of injury or mortality; however, no measurable effects on populations would be expected. No adverse impacts are expected during operation/maintenance.

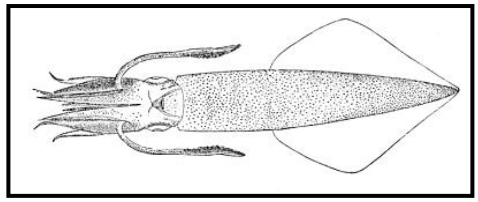
ADULTS. EFH for adult winter skate has been designated for the areas of highest relative abundance for this species based on NMFS trawl survey (1963-1999) and ELMR data. Only habitats with a substrate of sand and gravel or mud that occur within these areas of high abundance are designated as EFH.[18] Skates are known to remain buried in depressions during the day and are more active at night.

NEFSC bottom trawl surveys (Reid *et al.*, 1999b) captured adult winter skate during all seasons. The numbers of adults in spring and fall were much lower than for juveniles of the same two seasons. In winter, adult winter skate were scattered from Georges Bank to North Carolina; very few occurred in the Gulf of Maine. In the spring, they were also found from Georges Bank to North Carolina but, as with the juveniles, were also distributed nearshore throughout the Mid-Atlantic Bight and along Long Island as well as around Cape Cod and Massachusetts Bays. Few occurred in summer, being found mostly on Georges Bank, Nantucket Shoals, and near Cape Cod. In the fall, they were mostly confined to Georges Bank, near Nantucket shoals, and near Cape Cod, with very few found south of those areas. Adult little skate were collected in much fewer numbers than juveniles during the spring and fall Massachusetts inshore trawl surveys. The greatest numbers were found on the Atlantic side of Cape Cod and, in spring, south of Nantucket.

Based on the Massachusetts spring and fall inshore trawl surveys (Reid *et al.*, 1999b), adult winter skate were found at depth ranges between 1 and 75m, with most occurring between 6-20 m during the spring and between 6-25 m during the fall. In the spring, adults were found in waters ranging from 2-16^{o}C, with the greatest percentages between 6-12^{o}C. In the fall, they were found in waters ranging from 5-19^{o}C, with peak occurrences at 10^{o}C and a minor peak between 15-16^{o}C. NEFSC bottom trawl surveys (Reid *et al.*, 1999b) indicated that adult winter skate were found at salinities ranging from 30-36 ppt, with the majority occurring at 33 ppt in the spring and at 32 ppt in the fall. Impacts to adult winter skate habitat due to activities from the Project are expected to be minimal (see Section 4). Additionally, because winter skate adults are mobile, any individuals within the Project Area during construction and decommissioning would likely avoid or move from the area. Those skates that are buried and inactive during the day may experience higher levels of injury or mortality; however, no measurable effects on populations would be expected. No adverse impacts are expected during operation/maintenance.

3.3.7 Invertebrates

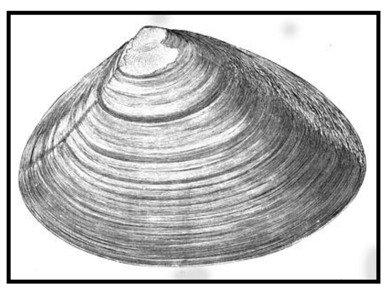
LONG-FINNED SQUID (*LOLIGO PEALEI*)



JUVENILES, OR "PRE-RECRUITS." EFH for long-finned squid pre-recruits consists of those pelagic waters over the continental shelf from the Gulf of Maine to Cape Hatteras. Older juveniles (sub-adults) are thought to overwinter in deeper waters along the edge of the continental shelf (Black *et al.* 1987). Based on NEFSC surveys (Cargnelli *et al.* 1999b) in Massachusetts, most juveniles were found in a temperature range of 10-13^{o}C in spring and 15-20^{o}C in fall. The preferred depth range was constant at 10-15 m. They were also collected in greater abundance during the fall than in spring, with concentrations in Buzzards Bay, around Martha's Vineyard and Nantucket, throughout Cape Cod Bay, in Massachusetts Bay, and north and south of Cape Ann. The spring concentrations occurred in Buzzards Bay and around Martha's Vineyard and Nantucket Islands (Cargnelli *et al.* 1999b). Impacts to pelagic waters from the Project are expected to be minimal (see Section 4). Additionally, because juvenile long-finned squid are highly mobile, any individuals within the Project Area during construction and decommissioning activities would likely avoid or move from the area. No adverse impacts are expected during operation/maintenance.

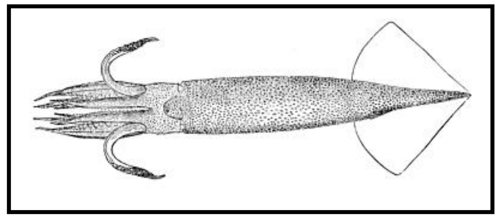
ADULTS, OR "RECRUITS." Adult long-finned squid also have EFH designated as the pelagic waters over the continental shelf from the Gulf of Maine to Cape Hatteras. Adults will migrate offshore during late fall and overwinter in warmer waters along the edge of the continental shelf, returning inshore during the spring and early summer (MAFMC 1996b). Off Massachusetts, larger individuals migrate inshore in April-May to begin spawning, while smaller individuals move inshore during the summer (Lange 1982). Based on NEFSC surveys (Cargnelli *et al.* 1999b) in Massachusetts, most adults were found in a temperature range of 10-13^{o}C in spring and 16-20^{o}C in fall. Preferred depths were 10-15 m in spring and 10-30 m in fall. Seasonal distribution is virtually identical to that of the juveniles (Cargnelli *et al.* 1999b). MDMF (2001b) survey trawls on Horseshoe Shoal have found long-finned squid are abundant year round within the Project Area. Impacts to pelagic waters from the Project are expected to be minimal (see Section 4). As with juveniles, adult long-finned squid are highly mobile and any individuals within the Project Area during construction and decommissioning activities would likely avoid or move from the area. No adverse impacts are expected during operation/maintenance.

SURF CLAM (*SPISULA SOLIDISSIMA*)



JUVENILES AND ADULTS. Because of the wide variability in age at maturity, juvenile and adult surf clams are discussed together (Cargnelli *et al.* 1999c). EFH for both life stages exists within the substrate to a depth of 1 m below the water/sediment interface, from the Gulf of Maine and eastern Georges Bank throughout the Atlantic Exclusive Economic Zone (EEZ). Studies reviewed in Cargnelli *et al.* (1999c) have shown the greatest concentration of surf clams are usually found in well-sorted, medium-grained sand, and are most common at depths of 8-66 m in the turbulent areas beyond the breaker zone. They are also found in a salinity range greater than 28 ppt, and in areas where bottom temperature rarely exceeds 25^{o}C (Cargnelli *et al.* 1999c). If there are small populations of surf clams in the Project vicinity, there may be localized impacts to surf clam habitat during the construction or decommissioning phases of the Project. Clam species in the direct footprints of Project activities may experience mortality, burial and/or displacement. Populations of benthic clams, however, are expected to repopulate the sandy environment quickly and no adverse impacts are expected during operation/maintenance activities.

SHORT-FINNED SQUID (*ILLEX ILLECEBROSUS*)



JUVENILES, OR "PRE-RECRUITS." EFH for juvenile short-finned squid is designated as those pelagic waters over the continental shelf from the Gulf of Maine to Cape Hatteras. Studies in Cargnelli *et al.* (1999a) state short-finned squid are highly migratory, moving offshore in the fall and not returning to the continental shelf until the following spring. The migratory paths during this time have not been thoroughly researched. In NEFSC Massachusetts surveys (Cargnelli *et al.* 1999a), very few juveniles were taken during the spring north of Nantucket, while only few were taken in the fall west of Nantucket and east of Cape Cod. The preferred bottom temperature range is less than 10.2^{o}C, a surface temperature range between 14.6-20.5^{o}C, and a depth range from 27-55 m. Juveniles were also taken in a salinity range of 34-37 ppt. Short-finned squid exist mainly in deeper waters, and are not particularly common within the Project Area. Impacts to the pelagic waters are expected to be minimal (see Section 4) Additionally, juvenile short-finned squid are highly mobile and any individuals within the Project Area during construction and decommissioning activities would likely avoid or move from the area. No adverse impacts are expected during operation/maintenance.

ADULTS, OR "RECRUITS." For adult short-finned squid, EFH also exists in the pelagic waters over the continental shelf from the Gulf of Maine to Cape Hatteras. Studies in (Cargnelli *et al.* 1999a) state short-finned squid are highly migratory, moving offshore in the fall and not returning to the continental shelf until the following spring. The migratory paths during this time have not been thoroughly researched. In NEFSC Massachusetts surveys (Cargnelli *et al.* 1999a), as with the juvenile population, very few adults were taken during the spring in the coastal waters of Massachusetts, while more were taken in the fall west of Nantucket and east of Cape Cod. The distribution was found to correlate well with the species' inshore-offshore migrations (Cargnelli *et al.* 1999a). In general, there are more adults present in the spring than juveniles due to size-related differences in the timing of migration (i.e., larger individuals migrate inshore earlier in the spring) (Cargnelli *et al.* 1999a). The preferred bottom temperature range is between 10.2-12.9^{o}C, a surface temperature range around 20.6^{o}C, and a depth range from 100-366 m. Short-finned squid exist mainly in deeper waters and are not particularly common within the Project Area. Impacts to the pelagic waters are expected to be minimal (see Section 4). Like juveniles, adult short-finned squid are highly mobile and any individuals within the Project Area during construction and decommissioning activities would likely avoid or move from the area. No adverse impacts are expected during operation/maintenance.

4.0 ANALYSIS OF IMPACTS

4.1 General Summary of Impacts

This section summarizes direct, indirect, and cumulative impacts to Essential Fish Habitat (EFH) and species with EFH designation during the construction, operation, maintenance, and decommissioning of the Project. Potential impacts that could occur during these Project phases are presented in Sections 4.1.1, 4.1.2, 4.1.3, and 4.1.4, respectively. Potential acoustical impacts that could occur during all phases of the Project are discussed separately in Section 4.1.5.

4.1.1 Impacts during Project Construction

The construction of the Project will involve the installation of 130 wind turbine generators (WTGs) in Nantucket Sound, an Electrical Service Platform (ESP) within the WTG array, inner-array cables to connect each WTG to the ESP, and two submarine cable circuits to connect the ESP to the landfall area in Yarmouth, Massachusetts. One monopile foundation will be constructed to support each of the 130 WTGs and six smaller monopile foundations will support the ESP. The monopiles will be installed using pile driving hammer technology and will be driven approximately 85 feet into the seabed. The total permanent direct area of benthic habitat loss from WTG and ESP monopiles will be approximately 29,525 square feet/0.68 acres, or approximately 0.0046% of the 24 square mile area defined as the total Project Area. To prevent scour around the monopiles, seabed scour control systems will be installed. These systems consist of mats of seagrass-like polypropylene "fronds" that serve to reduce the velocity of water circulation around the foundations, thereby preventing scour at the base of the monopiles. Initial installation of the scour control mats will directly impact approximately 110,160 square feet/ 2.53 acres of benthic habitat or approximately 0.016% of the total Project area. There could be additional temporary impacts to the seafloor in the vicinity of each proposed WTG associated with the anchors and/or jack-up barges involved in construction. Given the current knowledge of the types of anchors and vessels that could be used during the Project installation, approximately 20,861,856 square feet/479 acres of temporary disturbance associated with vessel positioning, anchoring, and anchor line sweep could be anticipated from installation of the WTGs and ESP. This temporary disturbance could comprise up to approximately 3.1% of the total Project area (see Section 5.3 of the DEIS-DEIR for further detail).

The two submarine cable circuits connecting the Wind Park to the landfall location and the inner-array cables connecting each WTG to the ESP will be installed in the seabed using hydraulic jet-plow embedment technology. This method utilizes pressurized water jets to create a localized path along the seafloor into which the cable system is immediately positioned. The sediment displaced by the jet-plow then begins to settle over the created path, thereby burying and protecting the cable. The localized pathway disturbed to install each circuit will be approximately four to six feet wide and eight feet deep to reach an approximate 6 foot burial depth. In total, jet plow cable embedment of the inner-array cables within the Wind Park will temporarily directly impact up to 2,471,040 square feet/57 acres of benthic habitat or approximately 0.375% of the total Project area. Jet plow cable embedment of the two submarine cable circuits connecting the Wind Park to the landfall location will temporarily directly impact up to 772,992 square feet/17.75 acres of benthic habitat or approximately 0.12% of the total Project area. Additionally, temporary impacts associated with cable installation barge positioning, anchoring, anchor line sweep, and the pontoons on the jet plow device are expected to occur along all cable installation paths. This results in a total anticipated temporary impact from anchoring and pontoons during the installation of the inner array cables and submarine cable system of approximately 35,920,896 square feet/825 acres of bottom area or approximately 5.4% of the total Project area (see Section 5.3 of the DEIS for further detail). The impacts associated with anchor line sweep during positioning of the cable lay vessel will also be localized and temporary and will primarily affect the sediments to a depth of between 3 and 6 inches (Algonquin Gas Transmission Company, 2000).

The transition of the interconnecting submarine cable system from water to land will be accomplished through the use of Horizontal Directional Drill (HDD) methodology in order to minimize disturbance within the intertidal zone and near shore area. HDD would be staged at the upland landfall area and involve the drilling of the boreholes from land toward the offshore exit point. Conduits would then be installed the length of the boreholes and the transmission line would be pulled through the conduits from the seaward end toward the land.

The offshore end of the conduits will terminate in a pre-excavated pit where the jet plow cable burial machine will start. To further facilitate the HDD operation, a temporary cofferdam will be constructed using steel sheet piles at the end of the boreholes. Approximately 840 cubic yards of sediment will be excavated from the area inside the cofferdam to expose the seaward end of the borehole. The top of the sheet piles will be cut-off approximately 2 feet above mean high water to contain any turbidity associated with the dredging. The excavated material will be disposed of at an approved upland disposal location. The area enclosed by the cofferdam will be approximately 2,925 square feet, a minimal area compared to surrounding habitat in Lewis Bay. See Section 4.0 of the DEIS for more detailed information on the transition of the cable system from water to land.

Direct Impacts

Direct impacts resulting from Project construction may include localized habitat loss and creation, benthic organism mortality, burial and/or displacement, finfish mortality and/or displacement, temporary impacts due to elevated suspended sediment concentrations in the water, temporary impacts related to increased vessel traffic, and acoustical impacts from construction activities. These impacts are discussed in more detail below. Acoustical impacts are discussed in Section 4.1.5.

Installation of the monopiles, inner-array cables, and two submarine cable circuits will physically displace sediment at specific locations. As such, some direct, localized mortality or burial (from re-settling sediments) of benthic organisms is anticipated. The greatest areal impacts to surficial benthic habitat and to benthic invertebrates will occur from anchor positioning and anchor line sweep. However, as discussed in more detail in Section 5.3 of the DEIS, the total anticipated temporary impact to the upper sediments from anchoring would comprise less than 8 % of the total Project Area (see Section 5.3 of the DEIS). Due to the limited and contained nature of the nearshore dredging activities required for transitioning the submarine cable to the upland cable system in Lewis Bay, no substantial impacts to benthic or finfish habitat are expected during these activities.

In general, the disturbance of the benthic environment will be short-term and localized because many benthic invertebrate species are capable of opportunistically recolonizing benthic sediments after disturbance (Hynes 1970; Rosenberg and Resh 1993; Rhoads *et al.* 1978; Howes *et al.* 1997). These opportunistic invertebrates are considered "pioneer" species and are expected to be the earliest colonizers of the disturbed areas. Opportunistic invertebrates such as amphipods, polychaetes, and oligochaetes living in adjacent, undisturbed areas are likely to rapidly recolonize the disturbed area. Many benthic invertebrates with relatively short life cycles that disperse through reproduction (*e.g.,* bivalves) are likely to recolonize the disturbed areas during the first spawning season after disturbance. The scour control mats that are placed around each monopile to stabilize sediment will become colonized with benthic organisms, thus replacing some habitat that is lost.

Construction activities within the Project Area are likely to result in the temporary displacement of finfish in the immediate vicinity of the area of activity primarily as a result of vibration and sediment suspension. Finfish are expected to rapidly return to these areas once construction in the specific area is ceased or completed. Since benthic habitat is similar throughout much of the Project Area and the rest of Nantucket Sound, it is expected that finfish will be able to find suitable, undisturbed habitat during construction. As disturbed benthic habitat is recolonized by benthos, as discussed above, finfish will once again be able to fully utilize the benthic habitat from which they were temporarily displaced.

Construction activities are not expected to result in measurable direct mortality to juvenile and adult pelagic finfish since these life stages are mobile in the water column and are capable of avoiding or moving away from the disturbances associated with construction. During winter construction periods, demersal finfish may experience higher levels of injury or mortality since avoidance of anchors and anchor cables may be hampered due to sluggish response under cold water conditions. However, no measurable effects on populations would be expected. Displacement of juvenile and adult finfish is likely to be temporary and localized, as no stressor is likely to extend great distances or for long durations associated with any of the construction activities. There is no reason to believe that individuals will not move back into the specific areas following construction activities.

Although juvenile and adult finfish will experience minimal direct impacts from construction activities, demersal eggs and larvae of finfish may experience localized increases in physical abrasion, burial or mortality during Project construction due to their limited motility and sensitivity to elevated concentrations of suspended sediments. The greatest areal impacts to demersal eggs and larvae will occur from anchor positioning and anchor line sweep. However, the total anticipated temporary impact to the upper sediments from anchoring would comprise less than 8% of the total Project Area (see Section 5.3 of the DEIS). Larvae in the latter stages of development are capable of some motility, which may allow for movement from the construction area, thus minimizing impacts. Pelagic eggs and larvae are not likely to be substantially affected. Predatory fish species, which may feed on larvae, may be temporarily displaced from the area as a result of disturbance during construction activities.

The construction technology that will be used for this Project was selected specifically for its ability to keep sediment suspension and other habitat disturbance to a minimum; however, there will still be a localized and temporary increase in suspended sediment concentrations associated with installing the monopiles, scour control mats, inner-array cables, and the two submarine cable circuits. Demersal eggs and larvae not physically harmed by the construction equipment in the vicinity of monopile, inner-array and submarine cable system locations may be exposed to small increases in suspended sediment. Due to the predominant presence of fine to coarse-grained sand in Nantucket Sound, localized turbidity associated with project construction is anticipated to be minimal and confined to the area immediately surrounding the monopiles, the inner-array cables, and the submarine cable system route. Sediments disturbed by construction activities are expected to settle back to the sea floor within a short period of time (one to two tidal cycles). Pelagic eggs and larvae are not likely to be substantially affected.

Although elevated TSS levels can negatively impact the ability of some finfish to navigate, forage, and find shelter; substantial impacts are not expected due to the temporary and localized nature of the project-related turbidity. In addition, the Project Area is situated in a dynamic environment that is subject to naturally high suspended sediment concentrations in near bottom waters; therefore, finfish and other marine organisms in this area are accustomed to fluctuations in suspended sediment concentrations and should not be substantially affected by a temporary increase in turbidity from Project activities.

Sediment suspension during excavation of the HDD borehole ends in Lewis Bay will be minimal since these activities will be contained within the cofferdam. In addition, the top of the sheet piles for the cofferdam will be cut off approximately two feet above mean high water in order to contain turbidity associated with dredging for the HDD borehole end transition (see Section 4.3.5 of the DEIS).

Increased vessel traffic that will result from construction activities is not expected to adversely impact local fish populations. Different types of fish respond in different ways to vessel noises. Most fish tend to increase swimming speed when vessel noise is detected. Some pelagic species tend to dive deeper while demersal species make lateral movements. Typical distances to which fish react to vessel noises range from 100-200 meters (328-656 feet), although extremely noisy vessels can elicit responses as far as 400 meters (1,312 feet) away (Mitson, 1995). Finfish in the Project Area are likely to display avoidance behaviors to vessels; however, these behaviors will be short-term and will likely be similar to the avoidance behaviors observed during pleasure boat activity, ferry traffic, or fishing activity in the area. More detailed information on acoustical impacts of the Project on fish during construction are presented in Section 4.1.5.

Indirect Impacts

Indirect impacts to finfish that may result from Project construction activities are related to the mortality or displacement of benthic species which may serve as prey for various finfish species. As mentioned above, benthic species will be directly impacted in the footprint areas of the construction activities. Since many benthic species serve as prey for finfish, their mortality may temporarily displace some finfish feeding at that particular location. The greatest areal impacts to these benthic invertebrates will occur from anchor positioning and anchor line sweep. However, as discussed in more detail in Section 5.3 of the DEIS, the total anticipated temporary impact to the upper sediments from anchoring would comprise less than 8 % of the total Project Area (see Section 5.3 of the DEIS). Therefore, sufficient food base is expected to be available for foraging fish species. In fact, during actual construction disturbance activities, injured or displaced benthic invertebrates may provide a short-term opportunity for increased feeding by fish.

In general, the disturbance to the benthic environment from Project construction will be short-term and localized because many benthic invertebrates are capable of opportunistically recolonizing benthic sediments after disturbance (Hynes 1970; Rosenberg and Resh 1993; Rhoads *et al.* 1978; Howes *et al.* 1997). In addition, because benthic habitat is similar throughout Nantucket Sound, similar benthic communities (i.e., prey organisms) will be located in many areas and finfish will be able to find suitable prey in areas adjacent to the Project Area and other regions of the Sound. As disturbed benthic habitat is recolonized by benthos, as discussed above, finfish will resume foraging in those areas as prey items become more abundant. Therefore, impacts to finfish from mortality or displacement of prey species will be minimal.

The resettling of suspended sand-sized sediments in the water column as a result of displacement by construction activities will occur in the immediate vicinity of the monopiles, inner-array cables, and the two submarine cable circuits. Existing benthic community structure in Nantucket Sound is influenced by the area's dynamic sediment transport regime. The seabed in this area is mobile due to strong wind and tidal current conditions. Organisms living on or in these sandy sediments are adapted for mobility in sand and recovery from burial (Pratt 1973). Thus, the temporary and localized sedimentation resulting from Project construction is not expected to substantially alter benthic communities in the Project Area.

Another potential indirect impact to finfish from construction activities is the possible bioaccumulation of contaminants in tissue. If sediment that is suspended during construction activities is heavily contaminated, then benthic organisms and demersal species may be exposed to those contaminants, and fish foraging in the area could consume contaminated prey. Recent studies, however, indicate that sediments in the Project Area are predominantly sand, and that chemical constituent concentrations are below established thresholds in applicable reference sediment guidelines. Specifically, all of the chemical constituents detected in sediment core samples obtained from the Project Area had concentrations below Effects Range-Low (ER-L) and Effects Range-Median (ER-M) marine sediment quality guidelines (Long et al., 1995) (see Section 5.1 of the DEIS). Therefore, the temporary and localized disturbance and suspension of these sediments during foundation placement and inner-array and submarine cable system installation is not likely to adversely affect marine water quality conditions or result in the increased incorporation of contaminants at low trophic levels. Finfish are thus unlikely to experience increased bioaccumulation of contaminants via consumption of prey items from the Project Area as a result of the proposed Project.

During the nearshore installation, the release of contaminants from the HDD operation within Lewis Bay will be minimized through a drilling fluid fracture or overburden breakout monitoring program. This program will minimize the potential of drilling fluid breakout into waters of Lewis Bay. Although it is anticipated that drilling depths in the overburden will be sufficiently deep to avoid pressure-induced breakout of drilling fluids through the seafloor bottom, a bentonite monitoring program will be implemented for the detection of possible fluid loss (see Section 4.3.5 of the DEIS). In the unlikely event of drilling fluid release, the bentonite fluid density and composition will cause it to remain as a cohesive mass on the seafloor in a localized slurry pile similar to the consistency of gelatin. This cohesive mass can be quickly cleaned up and removed by divers and appropriate diver-operated vacuum equipment; thereby minimizing any long-term impacts to fish or EFH.

The submarine cable system has been routed to avoid areas of submerged aquatic vegetation (i.e. seagrass and eelgrass) mapped as part of the MADEP Eelgrass Mapping Inventory (1995). To supplement this existing information, a field investigation (diver inspection) was been conducted to determine the extent of SAV limits and densities for the area near the cable route off of Egg Island. Potential indirect impacts to SAV as a result of sediment resuspension would be minimized by maintaining an appropriate distance between the proposed jet plow embedment and the mapped SAV beds. The submarine cable system would be no closer than 70 feet (21.3 meters) from the edge of the eel grass bed located near Egg Island. Prior to the start of installation of the submarine cable system, a pre-construction SAV survey will be conducted to verify the limits of SAV previously surveyed in July of 2003.

Should SAV beds be identified in the vicinity of the proposed submarine cable system route, a post-construction monitoring plan will be developed to document potential indirect impacts from cable embedment and habitat recovery. If it is found that eelgrass beds have migrated back to the site of disturbance, mitigation of replanting the eelgrass would be accomplished.

Cumulative Impacts

In addition to the proposed Project, other activities which may contribute to cumulative impacts to fish and federally managed species would include other submarine cable or pipeline installations, dredging activities, trawling, pile supported marine structures and other offshore wind installations (which at this time are limited to a small scale project proposed off the coast of Hull Massachusetts, and a large installation proposed by Long Island Power Authority (LIPA) off the southern coast of Long Island). The cumulative impacts from various potential activities that may occur within the location and timeframe of the proposed Project are discussed below.

The submarine cable system would be placed adjacent to the eastern edge of the Federal Navigation Project in Hyannis Harbor. Maintenance dredging of the channel, if initiated at the same time as the jet plow installation of the cable system, could result in additional concurrent, cumulative sediment suspension and deposition. Hyannis Harbor was dredged in 1985, 1991, and 1998. No dredging is currently scheduled, but based on recent experience it could be needed in the next 3-4 years. If the cable installation is completed in 2006 as expected, these activities will not be concurrent. In any event, as discussed in Appendix 5.2-C, sediment deposition resulting from the cable installation would be minimal and localized, and would not substantially contribute to any cumulative impact. Since potential dredging will not likely occur simultaneously to the submarine cable installation, no other significant cumulative impacts to finfish (i.e. noise, habitat disturbance) are expected.

A new submarine transmission cable has been proposed by National Grid between Cape Cod and Nantucket. Its proposed route would only cross the Project's submarine cable route in the vicinity of Hyannis Harbor. Outside of Massachusetts waters, at its closest point the proposed route of the Nantucket Cable would be approximately 2 miles (3.2 km) from the Wind Park and its inner array cables in Nantucket Sound. Prior to final design and construction, the Applicants for both projects would need to coordinate plans, design, and schedule for installation of the cables at this crossing point. At this crossing, and in its near vicinity, the impacts of each project would be coincident in nature. However, because sediment suspension and deposition impacts from jet plow cable embedment are minimal and are of short duration, these temporary impacts are not likely to occur at the same time. Thus, the area would not likely have increased water column sediment loadings from the first project installation at the time the second project is constructed and no significant cumulative impacts to finfish are anticipated.

The submarine cable installation for the Cape Wind Project would cross Nantucket Sound's North Channel. North Channel is a naturally occurring and maintained passageway marked by USCG aids-to-navigation and is not designated as a Corps of Engineers Federal Navigation Project, and therefore is not subjected to maintenance dredging. Therefore, no significant cumulative effects to finfish are expected in the area of the North Channel crossing.

There are existing submarine cables that cross from Falmouth to Martha’s Vineyard and from Harwich to Nantucket. These submarine cables require routine maintenance. However, there are no significant cumulative impacts expected to finfish since the existing cables are approximately 13 miles (21 km) and 8 miles (13 km) away from the Project area, respectively.

It is possible that additional dredging may occur at shore-based marinas supporting boating activities throughout the Project area. However, these marina dredging projects, if they were to occur, are very localized and not likely to result in sediment suspension and deposition that would be coincident with the Project’s cable installation (the closest point of which would be a minimum of .5 miles (805 meters) from the closest marina), nor would the impacts to finfish from these activities be substantial. Thus no significant cumulative impacts are anticipated from such activities

4.1.2 Impacts During Project Operation

The following subsections separately describe the potential impacts on finfish and EFH that may occur during normal operation of the WTGs (Section 4.1.2.1) and the inner-array cables and submarine cable system (Section 4.1.2.2).

4.1.2.1 Wind Turbine Generators (WTGs)

Direct Impacts

The direct impacts on fish and EFH associated with the operation of the WTGs may potentially involve submarine vibration and sound from the WTGs; increased vessel traffic; shading; alterations to currents, waves and circulation; habitat shift from non-structure oriented to structure-oriented system, and WTGs acting as fish aggregating devices.

Based on modeling simulations to evaluate underwater sound during operation and studies conducted at existing wind farms in Europe, it is anticipated that sound emissions from the WTGs will not substantially affect finfish populations in the area. Detailed information on acoustical effects on finfish are presented in Section 4.1.5 of this assessment and Section 5.11 of the DEIS.

As with construction, increased vessel traffic from operation and maintenance activities in the Project vicinity will likely result in temporary avoidance behavior by finfish. These behaviors, however, will be short-term and will likely be similar to the avoidance behaviors observed during pleasure boat activity, ferry traffic, or fishing activity in the area.

It is not anticipated that the limited shading effect from the WTGs and ESP will adversely affect finfish. Because the 130 WTGs will be spaced approximately 0.34 by 0.54 nautical miles apart, the shading from the WTGs on the water will have little direct impact on the finfish community. The ESP will have a surface area of 20,000 square feet that could potentially affect the benthic habitat beneath this location as a result of its shading effect. However, it is expected that the direct impacts of this shading on the benthic habitat will be negligible given that the ESP will be located approximately 39 feet above the MLLW datum plane in 28 feet of water and occupies a very small area of a commonly occurring benthic habitat.

Any slight alterations in waves, currents, or water circulation in the immediate vicinity of each WTG are not expected to adversely affect finfish or EFH. As described in Section 5.2 and Appendix 5.2-A of the DEIS, no far-field effects are anticipated from the operating WTG array since they are spaced approximately 0.34 to 0.54 nautical miles apart. Therefore no impacts to finfish populations are expected.

The presence of 130 WTG monopile foundations and 6 ESP piles in Nantucket Sound has the potential to shift the area immediately surrounding each monopile from a non-structured system to a structure-oriented system, with potential localized changes to benthic and finfish community assemblages. Both pelagic and more demersal finfish species may tend to congregate around the monopiles. However, the WTGs within the array will be spaced approximately 0.34 by 0.54 nautical miles apart and the additional amount of surface area being introduced is relatively inconsequential (approximately 1,200 square feet per tower assuming an average water depth of 30 feet below MHW). Therefore, the overall environment and finfish species composition in the Project Area and Nantucket Sound is not predicted to substantially change from pre-Project conditions.

The WTG monopile foundations and ESP piles may attract finfish and benthic organisms, thereby acting as fish aggregating devices (FADs). Bombace (1997) states that man-made submarine structures can serve to reduce the mortality rate during the critical recruitment phase, increase food availability, and provide shelter for reproductive adults. Bohnsack (1989) states that species most likely to benefit from artificial structures, such as the monopiles, are those with demersal, philopatric, territorial, and reef-obligate life histories. Several species with EFH designation within the Proposed and alternative site areas in Nantucket Sound display these characteristics in some or all of their life history stages, and thus may benefit from the presence of the monopiles. These species include Atlantic cod, black sea bass, and scup. However, as stated above, because the WTGs within the array will be spaced 0.34 by 0.54 nautical miles apart, the overall environment and finfish species composition in the Project Area and Nantucket Sound is not predicted to substantially change from pre-Project conditions.

Indirect Impacts

It is unlikely that finfish prey organisms will be displaced due to submarine vibration occurring during operation of the WTGs. The presence of fish near European wind farms suggests that prey items are also available near the wind turbines while they are in operation. No indirect impacts to fish or EFH are expected to be associated with the normal operation of the WTGs. In addition, vessel traffic and associated vessel noise is not expected to adversely affect prey species of finfish.

Cumulative Impacts

As discussed above, based upon the lack of any other active USACE Section 10 Applications proposing similar large-scale offshore wind power generation projects or other offshore projects in Federal waters off the New England coast, it is anticipated that the cumulative impacts from this project and other potential offshore facilities will be negligible. It is anticipated that smaller projects ranging from single turbines to less than ten turbines will make up the bulk of the offshore wind generation in the foreseeable near term. These are likely to be municipally sponsored, nearshore projects, and not developed in sufficient numbers to create any significant cumulative impacts.

Furthermore, the increased traffic from operation and maintenance activities (estimated to be 2 to 3 vessels per day) and any potential increase in recreational vessel activity in the project vicinity is not expected to significantly alter the behavior of finfish and/or federally managed species.

4.1.2.2 Inner-Array Cables and Submarine Cable System

Direct Impacts

The only potential direct impacts to fish species during the normal operation of the inner-array cables and two submarine cable circuits are related to the electromagnetic/thermal emissions from these cables. These impacts, however, are expected to be negligible. The cable system (for both the inner-array cables and each of the submarine cable circuits) is a three-core solid dielectric AC cable design, which was specifically chosen for its minimization of environmental impacts and its reduction of any electromagnetic field. The proposed inner-array and submarine cable systems for the Project will contain grounded metallic shielding that effectively blocks any electric field generated by the operating cabling system. Since the electric field will be completely contained within those shields, impacts are limited to those related to the magnetic field emitted from the submarine cable system and inner-array cables. As described in Section 5.13 of the DEIS, the magnetic fields associated with the operation of the inner-array cables or the submarine cable system are not anticipated to result in an adverse impact to fish species (ICNIRP 2000; Adair, 1994; Valberg et al. 1997).

Because the inner-array cables and the two submarine cable circuits connecting the Wind Park to the landfall will be buried approximately 6 feet below the seabed, they will not pose a physical barrier to fish passage. The considerable depth to which the cables will be buried will allow benthic organisms to colonize and demersal fish species to utilize surface sediments without being affected by the cable operation. The burial depth also minimizes potential thermal impacts from operation of the inner-array cables and two submarine cable circuits. In addition, the inner-array and submarine cable systems utilize solid dielectric AC cable designed for use in the marine environment that does not require pressurized dielectric fluid circulation for insulating or cooling purposes. Neither finfish nor federally managed species will be directly impacted during the normal operation of the inner-array or submarine cable systems.

Indirect Impacts

No significant indirect impacts to fish or federally managed species are expected from the operation of the inner-array cables or submarine cable system.

Cumulative Impacts

No significant cumulative impacts to fish or federally managed species are expected from the operation of the inner-array cables or submarine cable system.

4.1.3 Impacts During Project Maintenance

Maintenance required for the 130 WTGs would be distributed among two to three crews, thus likely resulting in daily trips to the Wind Park estimated to be at least 250 days per year. The main potential impacts to fish and federally managed species associated with maintenance activities would be increased vessel traffic in the area. Impacts to fish from this increased vessel activity are not expected to be any different from those associated with pleasure boat use, ferry traffic, or fishing vessel use of the area.

In the event that a WTG or a section of the inner-array or submarine cable systems require repair during operation, methodologies for conducting this repair are expected to be similar to those used during construction and therefore impacts are expected to be similar to potential construction impacts previously identified. However, impacts would be limited to the immediate vicinity of the WTG or portion of the cable system requiring repair.

No other direct, indirect or cumulative impacts are anticipated from maintenance of the WTGs, ESP, or the submarine cable systems.

4.1.4 Impacts During Project Decommissioning

The approximate design life of the Project is 20 years, after which the decommissioning of the Project will occur. Decommissioning the Project involves dismantling the WTGs and ESP, removing scour control mats, removing the inner-array cables and submarine cable system, and transporting all parts to shore for recycling. In deconstructing the WTGs down to the transition piece, the blades, hub, nacelle and tower would come apart in the same manner that they were put together utilizing similar equipment. The parts would be brought to shore for reuse or recycling. The monopile, with the transition piece, would be cut off at the mud line followed by the removal of the sediment within it to a suitable depth (approximately 6.5 feet (2 meters) below the level of the seabed). Once the sediments have been removed, the remaining monopile would be cut off at a depth of approximately 6.5 feet (2.0 meters) below the surface. The objective of the decommissioning process will be to return the Project Area to its pre-Project state (see Section 4.0 of the DEIS for a complete discussion of the decommissioning process). Following decommissioning, there should be no interferences with normal uses of the region nor should there be any adverse environmental impacts. The potential impacts associated with decommissioning are expected to be similar or less than those associated with Project construction due to the lack of pile driving activities associated with construction (see Section 4.5 of the DEIS). Finfish species and federally managed species will experience minimal impacts.

Direct Impacts

Project decommissioning may directly impact the benthic habitat and benthic communities that became established over the 20 year lifespan of the Project as the scour control mats, inner-array cables, and submarine cable system are removed. As with construction, it is expected that the impact to benthic habitat and the benthic community during decommissioning will be temporary and localized. Decommissioning activities within the Project Area are likely to result in the temporary displacement of finfish in the immediate vicinity of the area; however, finfish are expected to rapidly return to these areas once decommissioning in the specific area is ceased or completed. Since benthic habitat is similar throughout much of the Project Area and the rest of Nantucket Sound, it is expected that finfish will be able to find suitable, undisturbed habitat during decommissioning. Some mortality to benthic species will occur from the physical removal of Project structures. However, as mentioned above, benthic communities that are disrupted are expected to recolonize quickly following the disturbance. As disturbed benthic habitat is recolonized by benthos, finfish will once again be able to fully utilize the benthic habitat from which they were temporarily displaced.

No direct physical impacts to juvenile or adult pelagic finfish are expected since these organisms are mobile and will avoid or move away from the area during decommissioning activities. During winter construction periods, demersal finfish may experience higher levels of injury or mortality since avoidance of decommissioning activities may be hampered due to sluggish response under cold water conditions. However, no measurable effets on populations would be expected. Some direct impacts to demersal eggs and larvae may result during Project decommissioning as sediments become suspended in the water column and subsequently re-settle to the bottom when the scour control mats, inner-array cables, and submarine cable system are removed. Again, as anticipated during construction activities, decommissioning may cause localized increases in physical abrasion, burial or mortality to these organisms from elevated suspended sediment concentrations. The predominantly sandy sediments disturbed by structure and cable removal activities are expected to settle back to the sea floor rapidly. No substantial impacts to more pelagic-oriented eggs and larvae are expected since the elevated suspended sediment concentrations will remain primarily in bottom waters.

Similar to construction activities, increased vessel traffic and some minor acoustical impacts will result from decommissioning activities. As previously discussed, finfish in the Project Area may display avoidance behaviors to the increased traffic; however, these behaviors will be short-term and will likely be similar to the behaviors observed during pleasure boat activity, ferry traffic or fishing activity in the area. Acoustical impacts are expected to be of lower intensity during decommissioning activities and are not likely to cause any impacts to finfish other than minor avoidance behaviors.

The presence of 130 WTGs and 6 ESP piles in Nantucket Sound has the potential to shift the area immediately surrounding each monopile from a non-structured system to a structure-oriented system, with potential localized changes to benthic and finfish community assemblages. However, as discussed above in Section 4.1.2.1, because the WTGs within the array will be spaced approximately 0.34 by 0.54 nautical miles apart, the overall environment and finfish species composition in the Project Area and Nantucket Sound is not predicted to substantially change from pre-Project conditions. Therefore, removal of the monopiles is not expected to substantially change the overall finfish species composition, but will result in a localized shift from a structure-oriented habitat near the WTGs to the original shoals-oriented habitat present prior to the Project.

Several species with EFH designation within the Proposed and alternative site areas in Nantucket Sound may benefit from the presence of the monopiles, which may act as fish aggregating devices and provide additional habitat. These species include Atlantic cod, black sea bass, and scup. Removal of the monopiles will eliminate this structure-oriented habitat that these species prefer and may cause these species to disperse elsewhere. If any of these fish species were subject to increased fishing pressure during the life of the Project, removal of the monopiles may allow subsequent dispersal of the aggregated fish, thereby reducing fishing pressure on these species in the Project Area.

Indirect Impacts

Indirect impacts to finfish that could result from Project decommissioning activities are related to the mortality or displacement of benthic species which may serve as prey for various finfish species. As mentioned above, benthic species will be directly impacted as scour control mats, inner-array cables, and the submarine cable system are removed. Since many benthic species serve as prey for finfish, their mortality may temporarily displace some finfish feeding at that particular location. However, because benthic habitat is similar throughout much of the Project Area and the rest of Nantucket Sound, similar benthic communities (i.e., prey organisms) will be located in many areas and finfish will be able to find suitable prey during Project decommissioning. Additionally, opportunistic benthic species will likely re-colonize the disturbed areas quickly and finfish will resume foraging in those areas as prey items become more abundant.

As previously discussed, chemical constituents detected in sediment core samples obtained from the Project Area had concentrations below Effects Range-Low (ER-L) and Effects Range-Median (ER-M) marine sediment quality guidelines (Long et al., 1995) (see Section 5.1 of the DEIS). As long as sediments in the Project Area remain free of contaminants during the 20-year lifespan of the Project, the temporary and localized disturbance and suspension of these sediments during removal of structures, scour control mats and cables is not likely to adversely affect marine water quality conditions or result in the increased incorporation of contaminants by lower trophic levels or fish in these areas of Nantucket Sound.

Cumulative Impacts

Cumulative impacts from decommissioning the project, will be similar to the cumulative impacts discussed above for construction impacts from the Project. No significant cumulative impacts to fish or federally managed species are expected from dismantling the WTGs and ESP or removing scour control mats, the inner-array cables, and submarine cable system. Any impacts from decommissioning activities are expected to be localized and temporary.

4.1.5 Auditory Impacts during Project Construction, Operation, and Maintenance

4.1.5.1 Background on Acoustics

Sound can be measured in many terms, including frequency and sound pressure. Frequency is the rate of the sound wave vibration and is measured in cycles per second or hertz (Hz) (Richardson et al., 1995). For airborne and underwater sound pressure, the standard unit of measurement is the decibel (dB), a logarithmic scale formed by taking 20 times the $\log_{10}$ of a ratio of two pressures: the measured sound pressure divided by a reference sound pressure. Above air sound is referenced to 20 µPa[20], while underwater sound is referenced to 1 µPA. As a result, an identical sound pressure wave in air and underwater is recorded differently in the two fluids. For example, a sound pressure of 80 dB in air is equivalent to 106 dB underwater, i.e., the underwater scale is shifted 26 dB higher than the air scale. There are also substantial differences in ambient (background) sound levels in air and in the ocean, and in the frequency weighting that is used in the two media. Thus, the reader should not try to equate dB levels reported for water with those in air, or vice-versa.

A sound can also be transient or continuous. A transient sound (i.e., an explosion) has an obvious starting and stopping point while a continuous sound (e.g., offshore oil drill) is more or less persistent. The monopiles for the Project will be installed using pile driver technology and a pile driver is categorized as a repeating transient sound.

4.1.5.2 Acoustical Impacts to Fish

Section 5.11 of the DEIS discusses the anticipated acoustic effects and potential impacts of the Project. Based on modeling and results from other wind farm projects, it is concluded that the Project will have no adverse impacts to wildlife. A small amount of localized and temporary noise will be generated in the marine environment from construction of the Project. The operation and maintenance phases will have very low-level acoustic effects, and underwater sound will not be measurable beyond a short distance from each monopile.

Construction:

[20] MicroPascals = 10^{-6} Newton/m^2.

Vella (2002) suggests that certain sounds associated with the construction of an offshore wind farm may have an adverse effect on local fish populations, causing them to move away from the area temporarily. The maximum submarine sound generated during the Project will occur during construction activities, particularly during the installation of the monopiles. The jet plow embedment process for laying the submarine cable system and inner-array cables produces no sound beyond typical vessel traffic. The cable installation barge will produce sound typical of vessel traffic already occurring in Nantucket Sound. No adverse impacts to fish are expected from the HDD methodology used to transition the submarine cable to the upland cable system in Lewis Bay. Due to the sound-insulating qualities of earthen materials (the sediment), and the fact that the drilling would take place through unconsolidated material, the HDD transition is not anticipated to transmit any vibration from the sediment to the water, i.e. it would not add any sound into the water column. The installation of sheet steel for the cofferdam will utilize a low-noise vibratory method and will not use impact pile driving. Therefore underwater sound effects from the cofferdam installation will also be minimal and temporary.

Finfish are likely to avoid the immediate area around a monopile while it is being driven. Nonetheless, as discussed in Section 5.11 of the DEIS, simulations of the temporary, maximum underwater sound expected to be produced by Project activities reveal levels will be below 180 dB beyond a 500 meter Initial Safety Radius for the protection of marine mammals. Therefore, at this distance, underwater sound will be well below levels that would cause permanent damage to finfish (see Table 5.4-5 in Section 5.4 of the DEIS).

Direct measurements made during the installation of the SMDS on Horseshoe Shoal, as well as modeling simulations to evaluate underwater sound during all phases of the Project, suggest that acoustical impacts on local fish populations will be minimal. Some localized effects may be experienced by fish near the construction activities if they do not move from the area. However, impacts to finfish will be minimized by the underwater sound level monitoring that will be conducted for protected marine species during initial construction using a NMFS-approved observer at the site (see Section 5.5 of the DEIS). Section 5.11 of the DEIS provides a detailed discussion of the sound levels that were measured and can be anticipated during construction activities of this Project.

Operation:

Once installed, the operation of the WTGs are not expected to generate substantial sound levels above baseline sound in the area. Fish are sensitive to vibration (underwater sound waves). The lateral line, a sensory organ that runs lengthwise along the body of fish, helps the fish to navigate and detect food in the water column. Research conducted at offshore wind farms in Europe suggest that the very low vibration from wind turbines do not impact fishes in the region. Dolphins have been observed congregating to feed around the turbines at Great Britain's first wind farm, Blyth Offshore in Northumberland (AMEC, 2002). Dolphins are recognized as possessing highly sensitive sensory systems and would presumably avoid the area if the vibration proved irritating or hazardous. Additionally, because dolphins were observed engaged in feeding behaviors around these turbines, fish (i.e., prey of the dolphin) were also likely present.

At the Näsrevet Windfarm in Sweden, Westerberg (1999) observed that cod appear to be more numerous in the waters immediately around the wind turbines than in nearby areas. Westerberg postulated that this species may have become habituated to the increase in decibel level during normal operation. This type of habituation has also been observed around oil rig platforms (Vella, 2002). Westerberg (1999) also reported that the normal operational sounds of a wind farm did not greatly impact the migration of eels.

Modeling simulations to evaluate underwater sound during all phases of the Project, suggest that impacts to finfish from normal operation of the WTGs will be minimal or non-existent. Background sound levels are reached within approximately 100 meters (328 feet) of any individual WTG, and levels 20 meters (66 feet) away from the WTG are generally less than 2 dBLs from baseline conditions. Section 5.11 of the DEIS presents a detailed discussion of the potential acoustical impacts of the project. No sound will be emitted from the inner-array cables or submarine cable system during Project operation.

Decommissioning:

Underwater sound generated by Project decommissioning is expected to cause temporary avoidance behavior in finfish in the Project vicinity. Sounds generated during monopile and cable removal are expected to be less than during pile driving operations, and thus are not likely to cause substantial impacts other than temporary avoidance behavior in finfish.

Vessel-related noise:
The only other sound generated from the Project will be related to increased vessel traffic. In order to protect human passengers, most ocean-going vessels are regulated as to their noise emissions above the water. However, the underwater noise generated by vessels is not similarly regulated. The elements of the typical vessel that may emit underwater noise include the propeller, engine, and gear box and the noise emission levels can vary depending on the configuration of these elements as well as the speed, size, and freight of the vessel. According to a report released by the International Council for the Exploration of the Sea (ICES), fish normally show a variety of avoidance behaviors when a noise-emitting vessel is detected. Different types of fish respond in different ways to noise originating from ocean vessels: pelagic species tend to dive deeper in the water column while demersal species make lateral movements. Most fish species, whether pelagic or demersal, have been observed to increase their swimming speed when vessel noise is detected. The typical distance at which fish react to vessel noise is generally 100-200 meters (328-656 feet), although extremely noisy vessels can elicit responses as far as 400 meters (1,312 feet) away. (Mitson 1995). Finfish in the Project vicinity are likely to display avoidance behaviors to vessels, however, these behaviors will be short-term and will likely be similar to the avoidance behaviors observed during pleasure boat activity, ferry traffic or fishing activity in the area.

5.0 CONCLUSIONS

Construction, operation, maintenance, or decommissioning of the Project is not expected to cause substantial impacts to EFH or species with EFH designation. The impacts to benthic habitat that will occur from the installation and removal of the monopiles (including the scour control mats), inner-array cables, and submarine cable system will be localized and temporary. The disruption of the bottom habitat may result in the temporary displacement of juvenile and adult species with EFH designation; however, as the habitat is quickly re-colonized by benthic organisms, the various species with EFH designation will return to the area. During the life of the Project, the monopiles may serve to aggregate certain species with EFH designation. Following completion of the Project and removal of the structures, the distribution of the species with EFH designation should not differ substantially from the distribution observed prior to the start of the Project.

Project construction or decommissioning is not expected to result in measurable direct mortality to adult and juvenile pelagic finfish since these life stages are mobile in the water column and are capable of avoiding or moving away from the disturbances associated with these activities. During winter construction periods, however, demersal finfish may experience higher levels of injury or mortality since avoidance of construction disturbances may be hampered due to sluggish response under cold water conditions. No measurable effects on populations would be expected. Displacement of juvenile and adult finfish is likely to be temporary and localized, as no stressor is likely to extend great distances or for long durations associated with any of the construction activities. Several of the species with EFH designation that have demersal eggs and larvae (i.e., winter flounder) may experience localized increases in physical abrasion, burial or mortality during both Project construction and decommissioning due to their limited motility. Larvae in the latter stages of development are capable of some motility, which may allow for movement from the construction or decommissioning area. Pelagic eggs and larvae are not likely to be substantially affected since activities likely to harm these life history stages will be confined primarily to the benthic area and lower portion of the water column.

The other potential impacts during the life of the Project pertain to increased vessel traffic, the construction-related noise during installation of the monopiles, and the sound and vibration from the operating WTGs. As discussed above, no substantial impacts to EFH or species with EFH designation are expected to result from the construction-related sounds or from the limited underwater sounds and vibration during Project operation. Similarly, no impacts are likely to result from the slight increase in vessel traffic. Although the noise emitted from Project vessels may result in temporary avoidance behavior by fish, these behaviors will be short-term and will likely be similar to the avoidance behaviors observed during pleasure boat activity, ferry traffic or fishing activity already occurring in the area.

Impacts to EFH and species with EFH designation are anticipated to be temporary and localized in nature; therefore, little mitigation will be required. A summary of how the Project has been designed to avoid, minimize or mitigate impacts to EFH and species with EFH designation is provided below.

The Project has been planned, sited, and designed to avoid or minimize impacts to finfish and finfish habitat within the Project Area. While limited localized impacts are anticipated during Project construction and operation, measures will be implemented to prevent and minimize these impacts. These measures include using state-of-the-art hydraulic jet plow equipment for cable installation (see Section 4.0 of the DEIS), using monopile foundations for WTGs, and conducting post-construction monitoring to document habitat disturbance and recovery (see Section 6.0 of the DEIS).

The monopile-type foundation system represents the foundation system type that would result in the least amount of seabed disturbance (see Sections 3.0 and 4.0 of the DEIS). Minimal disturbance of sediment will take place by WTG installation activities. This installation method would result in only temporary impacts to finfish and finfish habitat in the immediate vicinity of the construction activities. During installation of the monopiles, impacts from pile driving equipment will be minimized by using a "soft start" of the pile driving equipment to allow fish to move away from the area in response to construction sound.

The Project also minimizes impacts by using jet plow embedment methods for installing the inner-array and submarine cable systems. The jet plow method is considered to be the most effective and least environmentally damaging alternative when compared to traditional mechanical dredging and trenching operations. This method of laying and burying the cables simultaneously ensures the placement of the submarine cables at the target burial depth with minimum bottom disturbance and the majority of fluidized sediment settling back into the trench. Jet plow embedment is also the installation methodology that appears to be preferred by state and federal regulatory agencies based on review of past precedent setting projects. Installation of the submarine cables by jet plow embedment minimizes sediment disturbance and suspension and results in only temporary impacts to finfish resources and habitat in and immediately adjacent to the cable installation areas. Impacts to finfish and finfish habitat in Lewis Bay within 200 feet of shore will be minimized by using HDD methodology to transition the submarine cable system to the upland. HDD techniques also appear to be favored by state and federal regulatory agencies based on favorable comments and past approvals of projects.

Furthermore, should SAV beds be identified in the vicinity of the proposed submarine cable system route, a post-construction monitoring plan will be developed to document potential indirect impacts from cable embedment and habitat recovery. If it is found that eelgrass beds have migrated back to the site of disturbance, mitigation of replanting the eelgrass would be accomplished.

6.0 WORKS CITED

Able, K.W. and M.P. Fahay. 1998. The first year in the life of estuarine fishes in the Middle Atlantic Bight. Rutgers Univ. Press, N.J.

Able, K.W., M.P. Fahay, and G.R. Shepherd. 1995. Early life history of black sea bass, *Centropristis striata*, in the Mid-Atlantic Bight and New Jersey estuary. *Fish. Bull.* **93**: 429-445.

Able, K.W., R.E. Matheson, W.W. Morse, M.P. Fahay, and G. Shepherd. 1990. Patterns of summer flounder *Paralichthys dentatus* early life history in the Mid-Atlantic Bight and New Jersey estuaries. *Fish. Bull.* **88**: 1-12.

Adair RK. 1994. Constraints of thermal noise on the effects of weak 60-Hz magnetic fields acting on biological magnetite. Proceedings National Academy Sciences USA 91:2925-2929.

Algonquin Gas Transmission Company. 2000. USACE Section 404/10 Permit Application for the HubLine Pipeline Project. November 30, 2000.

Allen, D.M., J.P. Clymer, III, and S.S. Herman. 1978. Fishes of Hereford Inlet estuary, southern New Jersey. Lehigh Univ., Dept. Biol. and Cent. Mar. Environ. Stud. and the Wetlands Institute. 138 pp.

AMEC. 2002. Lynn Offshore Wind Farm Environmental Impact Statement Non-Technical Summary. 18 pp. http://www.amec.com/uploadfiles/LynnNTS.pdf

Bigelow, H.B. and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. *U.S. Fish Wildl. Serv. Fish. Bull.* **53**: 577 pp.

Black, G.A.P., T.W. Rowell, and E.G. Dawe. 1987. Atlas of the biology and distribution of the squids *Illex illecebrosus* and *Loligo pealei* in the northwest Atlantic. *Can. Spec. Pub. Fish. Aquat. Sci.* **100**: 62 pp.

Bohnsack, J. A. 1989. Are high densities of fishes at artificial reefs the result of habitat limitation or behavioral preference? Bulletin of Marine Science 44, 631-45.

Bombace, G. 1997. Protection of biological habitats by artificial reefs; *In* A.C. Jensen (ed) European Artificial Reef Research, Proceedings of the 1st EARRN Conference, Ancona Italy March 1996. Pub. Southhampton Oceanography Centre, Southhampton, UK. 449 pp.

Buckley, J. 1989. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic) – winter flounder. U.S. Fish Wildl. Serv. Biol. Rep. **82**(11.87). U.S. Army Corps of Engineers, TR EL-82-4. 12 pp.

Bumpus, D.F., R.E. Lynde, and D.M. Shaw. 1973. Physical oceanography. Pp. 1-1 to 1-72, *in* Coastal and Offshore Environmental Inventory: Cape Hatteras to Nantucket Shoals. Marine Publication Series No. 2. Univ. of Rhode Island, Kingston, RI.

Bumpus, D.F., W.R. Wright, and R.F. Vaccaro. 1971. Sewage disposal in Falmouth, Massachusetts: Predicted effect of the proposed outfall. *J. Boston Soc. Civ. Engin.* **58**: 255-277.

Burke, J.S. 1991. Influence of abiotic factors and feeding on habitat selection of summer and southern flounder during colonization of nursery grounds. PhD. Dissertation, North Carolina State Univ., Raleigh, N.C. 97 pp.

Burke, J.S., J.M. Miller, and D.E. Hoss. 1991. Immigration and settlement pattern of *Paralichthys dentatus* and *P. lethostigma* in an estuarine nursery ground, North Carolina, USA. *Neth. J. Sea Res.* **27**: 393-405.

Cargnelli, L.M., S.J. Griesbach, and C.A. Zetlin. 1999a. Essential Fish Habitat Source Document: Northern shortfin squid, *Illex illecebrosus*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-147. 21 pp.

Cargnelli, L.M., S.J. Griesbach, C. McBride, C.A. Zetlin, and W.W. Morse. 1999b. Essential Fish Habitat Source Document: Longfin inshore squid, *Loligo pealeii*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-146. 27 pp.

Cargnelli, L.M., S.J. Griesbach, D.B. Packer, and E. Weissberger. 1999c. Essential Fish Habitat Source Document: Atlantic surfclam, *Spisula solidissima*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-142. 13 pp.

Cargnelli, L.M., S.J. Griesbach, D.B. Packer, P.L. Berrien, D.L. Johnson, and W.W. Morse. 1999d. Essential Fish Habitat Source Document: Pollock, *Pollachius virens*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-131. 30 pp.

Casterlin, M.E. and W.W. Reynolds. 1982. Thermoregulatory behavior and diel activity of yearling winter flounder, *Pseudopleuronectes americanus*. *Environ. Biol. Fishes* **7**: 177-180.

Chang, S., P.L. Berrien, D.L. Johnson, and W.W. Morse. 1999. Essential Fish Habitat Source Document: Windowpane, *Scophthalmus aquosus*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-137. 32 pp.

Cross, J.N., C.A. Zetlin, P.L. Berrien, D.L. Johnson, and C. McBride. 1999. Essential Fish Habitat Source Document: Butterfish, *Peprilus triacanthus*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-145. 42 pp.

Fahay, M.P., P.L. Berrien, D.L. Johnson, and W.W. Morse. 1999. Essential Fish Habitat Source Document: Atlantic cod, *Gadus morhua*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-124. 41 pp.

Falkowski, P.G., C.N. Flagg, G.T. Rowe, S.L. Smith, T.E. Whitledge and C.D. Wirick. 1988. The Fate of a Spring Phytoplankton Bloom: Export or Oxidation? Continental Shelf Research 8: 547-584.

Festa, P.J. 1977. Observations on the summer flounder (*Paralichthys dentatus*) sport fishery in Great Bay, N.J. during summer of 1976 in reference to anoxic water conditions. Appendix VII. *In*: Oxygen depletion and associated environmental disturbances in the Middle Atlantic Bight in 1976. pp. 463-471. U.S. Natl. Mar. Fish. Serv. Northeast Fish. Cent. Woods Hole Lab Ref. Doc. No. 81-25. 54 pp.

Fritzsche, R.A. 1978. Development of fishes of the Mid-Atlantic Bight : An atlas of egg, larval, and juvenile stages. Vol. 5: Chaetodontidae through Ophidiidae. U.S. Fish Wildl. Serv. Biol. Serv. Porg. FWS/OBS-78/12. 340 pp.

Gabriel, W.L. 1992. Persistence of demersal fish assemblages between Cape Hatteras and Nova Scotia, northwest Atlantic. *J. Northwest Atl. Fish. Sci.* **14**: 29-46.

Godcharles, M.F. and M.D. Murphy. 1986. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (south Florida) – king mackerel and Spanish mackerel. U.S. Fish Wildl. Serv. Biol. Rep. **82**(11.58). U.S. Army Corps of Engineers, TR EL-82-4. 18 pp.

Goldberg, R., B. Phelan, J. Pereira, S. Hagan, P. Clark, A. Bejda, A. Calabrese, A. Studholme, and K. Able. In preparation. Habitat-specific patterns of abundance and distribution of young-of-the-year winter flounder, *Psedopleuronectes americanus*, in three northeastern U.S. estuaries. U.S. Natl. Mar. Fish. Serv., Northeast Fish Sci. Cent., Milford Lab., Milford, CT.

Gordon, R.B. and M.L. Spaulding. 1979. A nested numerical tidal model of the Southern New England Bight. Report to NOAA, Hampton, VA, from Univ. of Rhode Island, Kingston, RI.

Goud, M.R. and D.G. Aubrey. 1985. Theoretical and observational estimates of nearshore bedload transport rates. *Mar. Geol*. **64**: 91-111.

Heyerdahl, E.G. and R. Livingstone, Jr. 1982. Atlantic cod, *Gadus morhua*. *In* M.D. Grosslein and T.R. Azarovitz (eds.), Fish distribution. Pp. 70-72. MESA New York Bight Atlas Monograph 15. N.Y. Sea Grant Institute, Albany, NY.

Hildebrand, S.F. and W.C. Schroeder. 1928. Fishes of the Chesapeake Bay. U.S. Bureau of Fisheries, 1024: 366 pp.

Howe, A.B., T.P. Currier, S.J. Correira, and J.R. King. 1997. Resource assessments. Mass. Div. Mar. Fish. Proj. Rep. F-56-R (Seg. 2). 10 pp.

Howes, B.L., D.R. Schlezinger, J.A. Blake, and D.C. Rhoads. 1997. Infaunal “recovery” as a control of sediment organic matter remineralization and the fate of regenerated nutrients in Boston Harbor: 14th Biennial Estuarine Research Federation (ERF) International Conference - The State of Our Estuaries. Oct. 12-16, Providence, R.I. Abstracts; p. 84.

Hynes, H.B.N. 1970. The ecology of running waters. University of Toronto Press, Toronto. 555 pp.

Johnson, D.L., W.W. Morse, P.L. Berrien, and J.J. Vitaliano. 1999. Essential Fish Habitat Source Document: Yellowtail flounder, *Limanda ferruginea*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-140. 29 pp.

International Commission on Non-ionizing Radiation Protection (ICNIRP). 2000. Effects of Electromagnetic Fields on the Living Environment, Proceedings of the International Seminar on Effects of Electromagnetic Fields on the Living Environment. Ismaning, Germany, October 1999. R Matthes, JH Bernhardt, MH Repacholi (eds). ISBN 3-9804789-9-8. Märkl-Druck, München. 279 pp.

Lange, A.M.T. 1982. Long-finned squid, *Loligo pealei*. *In*, M.D. Grosslein and T.R. Azarovitz (eds.), Fish distribution. P. 133-135. MESA New York Bight Atlas Monograph 15. N.Y. Sea Grant Institute, Albany, NY.

Limeburner, R., R.C. Beardsley, and W. Esaias. 1980. Biological and hydrographic station data obtained in the vicinity of Nantucket Shoals, Mary 19789 – May 1979. Report WHOI-80-7. Woods Hole Oceanographic Institution, Woods Hole, MA. Report to NOAA Sea Grant Program. 87 pp.

Long, E. R., D. D. MacDonald, S. L. Smith, and F. D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. *Environmental Management* 19 (1): 81-97.

Lux, F.E. and F.E. Nichy. 1981. Movements of tagged summer flounder, *Paralichthys dentatus*, off southern New England. NOAA Tech. Rep. NMFS SSRF-752. 16 pp.

Massachusetts Division of Marine Fisheries (MDMF). 2001a. [personal communication]. V. Malkoski, November 2001

MDMF. 2001b. Data tables on commercial fisheries, transmitted via e-mail. Contact – Robert Johnston, Field Office, Pocasset, MA.

Mayo, R.K. 1982. An assessment of the scup, *Stenotomus chrysops*, population in the southern New England and Mid-Atlantic regions. U.S. Natl. Mar. Fish. Serv., Northeast Fish. Cent. Woods Hole Lab. Ref. Doc. No. 82-46. 61 pp.

McCracken, F.D. 1963. Seasonal movements of the winter flounder, *Pseudopleuronectes americanus,* (Walbaum) on the Atlantic coast. *J. Fish. Res. Board Can* **20**: 551-586.

Maurer D. & W. Leathem. 1981. Polychaete feeding guilds from Georges Bank, USA. Marine Biology 62: p. 161-171.

Mercer, L.P. 1989. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (South Atlantic) – black sea bass. U.S. Fish Wildl. Serv. Biol. Rep. **82**(11.99). U.S. Army Corps of Engineers, TR EL-82-4. 16 pp.

Mid-Atlantic Fishery Management Council [MAFMC]. 1996a. Amendment #8 to the summer flounder Fishery Management Plan: Fishery Management Plan and final environmental impact statement for the scup fishery. January 1996. MAFMC. [Dover, DE] 162 pp. + appendices.

Mid-Atlantic Fishery Management Council [MAFMC]. 1996b. Amendment #6 to the Fishery Management Plan and the final environmental impact statement for the Atlantic mackerel, squid, and butterfish fisheries. September 1996. MAFMC. [Dover, DE]

Mitson, R.B. 1995. Underwater Noise of Research Vessels: Review and Recommendations. Cooperative Research Report No. 209. International Council for the Exploration of the Sea, Denmark.

Mulkana, M.S. 1966. The growth and feeding habits of juvenile fishes in two Rhode Island estuaries. Gulf Res. Rep. 2: 97-167.

Neville, W.C. and G.B. Talbot. 1964. The fishery for scup with special reference to fluctuations in yield and their causes. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Fish. No. 459. 61 pp.

Northeast Utilities Service Company [NUSC]. 1989. Winter flounder studies. *In*: Monitoring the Marine Environment of Long Island Sound at Millstone Nuclear Power Station, 1989 Annual Report. 258 pp.

Ocean Surveys, Inc. July 2002. Marine Geophysical Survey and Sediment Sampling Program: Cape Wind Energy Project, Nantucket Sound, Massachusetts. Prepared for Environmental Science Services, Inc.

O'Hara, Charles J. and Oldale, Robert N. 1987. Geology, Shallow Structure, and Bedform Morphology, Nantucket Sound, Massachusetts. 1:125,000. United States Geological Survey Miscellaneous Field Studies Map MF 1911.

Packer, D.B., S.J. Griesbach, P.L. Berrien, C.A. Zetlin, D.L. Johnson, and W.W. Morse. 1999. Summer flounder, *Paralichthys dentatus*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-151. 89 pp.

Pereira, J.J., R. Goldberg, J.J. Ziskowski, P.L. Berrien, W.W. Morse, and D.L. Johnson. 1999. Essential Fish Habitat Source Document: Winter flounder, *Psedopleuronectes americanus*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-138. 39 pp.

Poole, J.C. 1962. The fluke population of Great South Bay in relation to the sport fishery. *N.Y. Fish Game J.* **9**: 93-117.

Pratt, S.D. 1973. Benthic fauna. Pp 5-1 to 5-55, *in* Coastal and Offshore Environmental Inventory – Cape Hatteras to Nantucket Shoals. Marine Publication Series No. 2. University of Rhode Island, Kingston, RI.

Reid R.N., L.M. Cargnelli, S.J. Griesbach, D.B. Packer, D.L. Johnson, C.A. Zetlin, W.W. Morse, and P.L. Berrien. 1999a. Essential Fish Habitat Source Document: Atlantic herring, *Clupea harengus*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-126. 30 pp.

Reid, R., F. Almeida, and C. Zetlin. 1999b. Essential fish habitat source document: Fishery independent surveys, data sources, and methods. NOAA Tech. Mem. NMFS-NE-122. 40p.

Rhoads, D.C., P.L. McCall, and J.Y. Yingst. 1978. The ecology of seafloor disturbance. *Am. Sci.* 66: 577-586.

Richards, C.E. 1967. Age, growth and fecundity of the cobia, *Rachycentron canadum*, from the Chesapeake Bay and adjacent Mid-Atlantic waters. *Trans. Amer. Fish. Soc*. **96**: 343-350.

Richardson, W.J., C.R. Greene, C.I. Malme, and D.H. Thomson (eds.). 1995. Marine Mammals and Noise. Academic Press, Inc: San Diego, CA..

Rosenberg, D.M. and V.H. Resh (eds). 1993. Freshwater Biomonitoring and Benthic Macroinvertebrates. Chapman & Hall, New York, N.Y. 488 pp.

Sanders, H. L. 1956. The biology of marine bottom communities. Bulletin of the Bingham Oceanographic Collection 15: 345-414.

Shaffer, R.V. and E.L. Nakamura. 1989. Synopsis of biological data on the cobia, *Rachycentron* *canadum* (Pisces: Rachycentridae). NOAA Tech. Rep. NMFS 82.

Sherman, K., M. Grosslein, D. Mountain, D. Busch, J. O'Reilly and R. Theroux. 1988. The Continental Shelf Ecosystem off the Northeast Coast of the United States. In: H. Postma and J.J. Zijlstra (eds.), Ecosystems of the World vol 27, p. 279-337. Elsevier Press, The Netherlands.

Steimle, F.W., C.A. Zetlin, P.L. Berrien, and S. Chang. 1999a. Essential Fish Habitat Source Document: Black sea bass, *Centropristis striata*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-143. 42 pp.

Steimle, F.W., C.A. Zetlin, P.L. Berrien, D.L. Johnson, and S. Chang. 1999b. Essential Fish Habitat Source Document: Scup, *Stenotomus chrysops*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-149. 39 pp.

Studholme, A.L., D.B. Packer, P.L. Berrien, D.L. Johnson, C.A. Zetlin, and W.W. Morse. 1999. Essential Fish Habitat Source Document: Atlantic mackerel, *Scomber scombrus*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-141. 35 pp.

Theroux, R.B. and R.L. Wigley. 1998. Quantitative composition and distribution of the macrobenthic invertebrate fauna of the continental shelf ecosystems of the northeastern United States. NOAA Tech. Rep. NMFS 140. NOAA, Washington, DC. 240 pp.

Valberg PA, Kavet R, Rafferty CN. 1997. Can low-level 50/60-Hz electric and magnetic fields cause biological effects? Radiation Research 148: 2-21.

Vella, G. 2002. Offshore Wind: The Environmental Implications. Utilities Project, Volume 2. University of Liverpool.

Westerberg, H. 1999. Impact Studies of Sea-Based Windpower in Sweden. Technische Eingriffe in marine Lebensraume.

Wigley, R. 1968. Benthic Invertebrates of the New England Fishing Banks, in "Underwater Naturalist", American Littoral Society, Vol. 5, No. 1.

Williams, G.C. 1975. Viable embryologenesis of the winter flounder, *Pseudopleuronectes americanus*, from –1.8 – 15^{o}C. *Mar. Biol (Berl).* **33**(1): 71-74.

PICTURES COURTESY OF:
http://www.wh.whoi.edu/photos/lineart/Species_By_Name/
http://www.newenglandsharks.com
http://dspace.dial.pipex.com/
http://www.horta.uac.pt/